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THE AMATEUR TELESCOPIST'S HANDBOOK

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LONDON
LONGMANS, GREEN, AND CO.
AND NEW YORK, 15 EAST 16TH STREET
1894

The Caxton Press
171–173 Macdougal Street, New York.

PRÆSIDI, PROFESSORIBUS GUBERNATORIBUSQUE

COLLEGII SANCTI JOHANNIS,

ANNAPOLE, IN TERRA-MARIÆ,

HONORIS AB EIS DONATI

MEMOR,

HOC OPUSCULUM DEDICAVIT

SCRIPTOR.

"THE works and design of the Omnipotent Creator are inscrutable to the most brilliant human intellect; yet enough is revealed, both with regard to the wondrous universe and our own mental capacity, to convince the reflecting mind that it is a mark of devotion which we owe to our Maker to study with earnestness the beautiful and harmonious works around us, however their immensity may at first bewilder us. He who zealously applies himself will verify the sacred promise, 'Those who seek shall find.' In worldly pursuits a long novitiate is devoted to acquire the imperfect concoctions of man; how much more is due to catch a glimpse of the imperishable laws of the CREATOR!"—ADMIRAL WILLIAM HENRY SMYTH.

PREFACE.

THIS little book is offered to amateurs in astronomy in the belief that it fills a want as yet unsupplied.

For the possessors of equatorially mounted telescopes of an aperture exceeding three or four inches, efficient guides are already in existence. Smyth's *Cycle of Celestial Objects* and Webb's *Celestial Objects for Common Telescopes* fulfil almost every requirement of such observers. But for the far larger number of students of astronomy whose instrumental equipment does not go beyond a two or three-inch altazimuth, these admirable works are to a considerable extent unsuited. The worker with an equatorial can quickly and easily direct his telescope to any object described in those mines of celestial wealth ; but for his humbler brother there is no resource but to laboriously locate the given star or nebula on a map, note its position with reference to other objects, and then search for it with the altazimuth. Moreover, these immense collections of celestial objects contain a very large number of bodies which are hopelessly beyond the reach of a small telescope ; and the novice knows not which among them may be expected to reveal themselves by the assistance of his little instrument, and is at a loss where to begin his scrutiny of the heavens. If all this work could be done for him ; if a selection could be made of such objects as are within the powers of, at most, a three-inch telescope, and the location of each of them be concisely and yet fully described with reference to objects visible

to the unaided eye, a vast quantity of uncertainty, difficulty, and labor would be cleared out of the student's path. And if, in addition to this, a method could be provided by which the use of a map by lantern-light could be entirely dispensed with, and the position of every star used in locating others could be ascertained almost at a glance, it is very evident that the drawbacks and difficulties encountered by the amateur observer would be greatly modified, if not in the main removed.

Precisely this is what has been done in the catalogue of between four and five hundred celestial objects contained in this book; and upon this fact is based the author's belief that the Handbook will fill a want in this field.

That portion of the book which treats of the principles, construction, care, and use of the Telescope is drawn from many sources, and contains, it is believed, more practical information upon the subject than any other one volume treating of this instrument. A certain knowledge of astronomy on the reader's part is assumed; but not more than can be obtained from any primer of the science.

The illustrations are limited to such as are necessary to convey essential information, and it will be noticed that no attempt has been made to give any of the diagrams of double stars which are so common in books upon this subject prepared for amateurs. Even if a pair of dead-white disks on a black ground could really represent the glittering and twinkling stars, they would not serve the purpose which is usually assigned for their existence, namely, to give the student an idea where to look for the companion of the star represented. For the apparent relative positions of the star and its *comes* change with the successive positions of the object in its course across the sky; and as these diagrams usually represent the rel-

ative positions of the components when the star is on the meridian, they would be useless for the purpose assigned when it was at any distance from that line.

No attempt has been made to treat of the Reflecting Telescope. This instrument is but little known in America, although it must some day come into favor in this country, as it has always been in England, especially since the introduction of the silvered-glass speculum, since its cheapness, in comparison with refractors of corresponding aperture, makes it, in one sense, preëminently the amateur's telescope. Should a future edition of this Handbook ever be called for, some space may be devoted to the Reflector.

In conclusion, the author trusts that this little work may prove a helpful and pleasant companion to amateur astronomers in the study of the sublimest of the physical sciences and the use of the noblest of optical instruments.

WASHINGTON, D. C.,
November, 1893.

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THE AMATEUR TELESCOPIST'S HANDBOOK.

CHAPTER I.

THE TELESCOPE: ITS PRINCIPLES AND POWERS.

AN opportunity to examine celestial objects by means of a telescope is one which is so eagerly embraced by almost all classes of people as to indicate that telescopic astronomy possesses a charm which should lead to its extensive cultivation; but the efforts of writers on this subject have been comparatively unsuccessful in persuading students of natural science to believe that a small telescope is capable of gratifying, in any real sense, the taste for these fascinating pursuits. The popular idea of the telescope is of a huge and costly instrument, the possession of which must necessarily be limited to educational institutions, public observatories, and wealthy amateurs; and the fact that most of the work of modern astronomy is done by such instruments serves to confirm this impression. The monster reflectors of Herschel, Rosse, and Lassell; the colossal refractors of Mount Hamilton, Chicago, and Washington, are the instruments suggested to the average mind by the word telescope; and a diminutive tube of two or three inches aperture is neglected and disdained as incapable of doing aught but tantalize the student who is unable to procure anything better. And

then, when the would-be possessor of a telescope comes to examine price lists, he is apt to stand aghast at the manner in which the cost of object glasses advances with every half inch of aperture ; and it is only too probable that he will surrender the idea of surveying the heavens through a glass of his own.

The catalogues of celestial objects given in this book should be, and the author hopes will be, an effectual refutation of the fancy that nothing can be done with a small telescope. There is scarcely an object contained in them which is not fairly within the compass of a good three-inch achromatic. The exceptions to and modifications of this statement will appear in their proper places ; but the reader is assured of the correctness of the general rule.

There is a tendency in certain quarters to encourage the amateur astronomer provided he wishes to do work of value to the science, but to speak with contempt of mere "star-gazing." This tendency is exhibited in more than one book prepared for the use of astronomical amateurs, and has served to discourage more than one student who was unable to provide himself with the means for doing serious astronomical work, or to acquire the necessary skill in using them.

Now, it might as well be stated at once that there is scarcely a possibility in these days that an amateur with a small altazimuth telescope can accomplish any work of scientific value. There are, indeed, certain fields open to him—*e.g.*, he may observe occultations by the aid of a good chronometer, and with skill and care may thus make some contribution toward the improvement of the lunar theory ; * but even assuming that he possesses a chronom-

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* Noble.

eter and the means for accurately regulating it, work of this kind is already being done by accomplished astronomers provided with the most perfect instruments which modern skill can construct. So of every other branch of telescopic astronomy. In earlier days, when astronomical instruments were less perfect, professional astronomers less numerous, and the magnificent observatories of modern times as yet unknown, the amateur with his little telescope might be a distinguished and valued co-laborer with the professional with his not very much larger instrument. That day is past; and it is most likely that the small telescope has done all of which it is capable in the way of original scientific work.

But surely what remains within the power of this humble little member of the mighty family of telescopes is not to be despised. To merely look with delight and wonder upon the twin glitterings of the double stars, the gorgeous splendor of the clusters, the pale glow of the nebulæ; to scan the wild scenery of the moon; to watch the huge spots drifting across the sun; to follow the satellites of Jupiter as they circle about the giant planet; to marvel at Saturn with his "wondrous rings"; to wait and watch for the startling phenomena of occultations and eclipses; and through all this to see the working of the majestic and glorious laws of the universe—this is not to be set aside as worthless. On the contrary, the mere "star-gazer" will find a never-failing pleasure in the contemplation of these stupendous objects; and even though he may accomplish nothing for science, he will enjoy the most refined, elegant, and fascinating of all scientific recreations.

The history of the refracting telescope divides itself into three periods: that of the Galilean telescope; that

of the Astronomical telescope, strictly so called ; and that of the Achromatic. While it is not within my purpose to give an elaborate account of the optical principles involved in these instruments, a brief explanation of them must necessarily be introduced as highly important to the telescopist.

The telescope, as invented (in all probability) by Jansen and Lippersheim, two spectacle-makers of Middleburg, Holland, and improved by Galileo, consists of a double convex lens placed at one end of a tube shorter than the focal length of the glass, at the other end of which is fixed a double concave lens. The rays of light from any object passing through the convex lens are in-

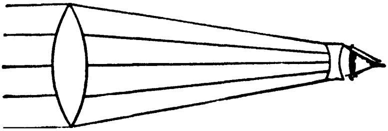

FIG. 1.

tercepted by the concave lens before the image can be formed, and converted into parallel rays which enter the eye of the observer applied to the latter lens.

This instrument, which in the hands of Galileo opened the magnificent career of modern practical astronomy, is now, by the irony of fate, known as the *non-astronomical telescope*. It still serves a useful purpose in the opera-glass ; but it was soon cashiered from the service of astronomy on account of several serious and radical defects. The first of these defects is that the full illuminating power of the telescope is not made available. A comparatively small number of the rays received by the convex object glass are transmitted through the concave

eye-lens ; and if we use an eye-lens of shorter focus, and nearer the object glass, it intercepts more of the rays, to be sure, but there is no point of the eye-lens at which the eye would receive pencils of light emanating from any considerable portion of the object. Mr. Proctor * compares the difference to that between looking through the small end of a cone-shaped roll of paper, and looking through the large end. In the first case the eye sees at once all that is to be seen through the roll (supposed fixed in position), and in the latter the eye may be moved about so as to command the same range of view, but *at any instant* sees over a much smaller range.

The fact that in a Galilean telescope the size of the field of view is dependent upon the size of the object glass is a defect, and so is the fact that any scratches, marks, or partial coverings placed upon the object glass are visible on looking through the telescope ; but the great defect of this instrument lies in the fact that in the Galilean telescope no real image is formed, owing to the interception of the collected rays by the eye-lens before they come to a focus at all. Since, then, no actual image exists, it is impossible to apply any measurements to it—a well-nigh fatal fault from an astronomical standpoint.

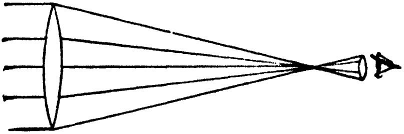

FIG. 2.

The *astronomical telescope*, in its primitive form, consists of a double convex lens which forms an inverted image of

* *Half-hours with the Telescope*, p. 8.

the object under examination, and a smaller double convex lens which magnifies the image.

The rays of light falling through the object glass are refracted to a focus in the tube, and the image thus formed is magnified by the small lens at the eye-end. By this arrangement of lenses the characteristic defects of the Galilean telescope are avoided. The size of the field of view is not dependent upon the size of the object glass. Scratches or marks on the object glass are not visible in the telescope, but only cause a certain loss of light, so that a portion of the object glass may be covered over, either at the centre or at the edges, for certain purposes, without the covering object being visible, and the whole of the light transmitted by the object glass becomes available. Moreover, the image, being real and not merely virtual, may be readily subjected to measurement, either angular or linear; a circumstance which alone would make this instrument preëminently the astronomical telescope.

But this primitive telescope has two most serious defects of its own which, if not removed or greatly modified, would have caused it to remain forever a clumsy and imperfect contrivance. These are known as *chromatic aberration* and *spherical aberration.** The first of these is due to the unequal refrangibility of the different colors of the spectrum. The image of an object thus does not lie in a flat field perpendicular to the optical axis of the telescope (*i.e.*, a line drawn from the centre of the objective to that of the eye-lens), but is in reality divided into a

* I omit all reference to the curvature of the image, as this defect is of no importance in practice, and the above discussion is merely elementary.

number of images of different colors lying one behind the other in the optical axis. Accordingly, when the eye-lens is set so as to magnify one of these images, a colored fringe due to the other images, enlarged by being out of focus, surrounds the image under examination. The other defect, that of spherical aberration, is due to the fact that the rays transmitted through the outer portions of a double convex lens are brought to a focus nearer the lens than those transmitted through the centre.

The correction of these faults was for more than a hundred years the great desideratum in practical astronomy. An effort was made to remedy them, and with some success, by grinding lenses of enormous focal length, which were elevated upon a pole and provided with mechanical appliances by which the observer could direct them to different parts of the heavens, and examine the images formed by them with an eye lens. One of these, now in the possession of the Royal Astronomical Society, was made by Huygens, and has a focal length of 123 feet; another was made for Louis XIV. which had a focal length of 136 feet; and Auzout had one of 600 feet, which preposterous machine he was unable to use for lack of a place on which to put it.

Sir Isaac Newton despaired of ever remedying these evils in the refracting telescope, and devoted his labors in this field to the construction of reflectors. But the discovery that the dispersive powers of different kinds of glass were not proportional to their refractive powers set opticians to work. This principle may be illustrated as follows: If a ray of sunlight be permitted to pass through a glass prism, it will be separated into a spectrum of a length proportional to the *dispersive* power of the glass, and it will be turned out of a straight course at an angle

proportional to its *refractive* power. If we now substilute for this prism another one of the same shape but of a different kind of glass, the spectrum may be of the same length but be thrown to a greater or less angular distance than by the first prism. Working upon this principle, John Dollond, of London, immortalized his name and founded modern telescopy by inventing the achromatic object glass in 1758. This consists of a double convex lens of crown glass combined, as in Fig. 3, with a plano-convex or concavo-convex lens of flint glass.

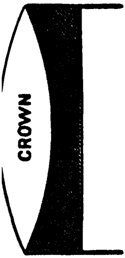

FIG. 3.

The proportion of the refractive and dispersive powers of these two kinds of glass is such that the flint glass neutralizes the dispersion caused by the crown glass in refracting the rays to a focus, leaving the latter free to form its image without color. The defect is not absolutely cured, but becomes of little moment except in examining an object of extraordinary brightness on a dark background—*e.g.*, Venus against a dark sky. The spherical aberration is also corrected by the figure given to the compound lens.

The tests as to the correction of chromatic and spherical aberration will be duly given when we come to consider the examination and trial of object glasses.

As the achromatic combination has superseded the simple double-convex object glass, so a combination of lenses has taken the place of the single eye-lens. The image formed by the most perfect achromatic objective would appear indistinct, distorted and colored, if viewed through a common double-convex lens. The first combination lens, or *eyepiece*, for magnifying the image was

invented by Huygens in the seventeenth century, and bears his illustrious name. It consists of two plano-convex lenses, mounted as in Fig. 4, with the convex sides of both turned toward the image. The distance between the lenses is equal to one-half the sum of their focal lengths, which produces an achromatic combination. This invaluable instrument is still in constant use, except in cases where micrometrical measurements are to be made.

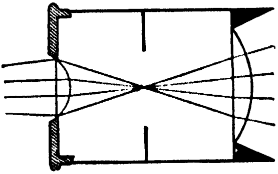

FIG. 4.

It is known as the *negative* eyepiece, as distinguished from the one presently to be described, because the image is formed between the lenses composing it. This position of the image renders it impossible to use the Huygenian eyepiece in cases where it is required that transit wires or a micrometer shall be used in the common focus of the objective and the eyepiece. In such a case the *positive* eyepiece, invented by Ramsden in the eighteenth century, is used. This is represented in Fig. 5. The lenses have their convex sides turned toward each other, and the image is formed just beyond the lens *a*, which is known in all eyepieces as the *field glass*, while *b* is known as the *eye glass*. The common focus of the object glass and the eyepiece can thus receive the wires of a micrometer or transit system.

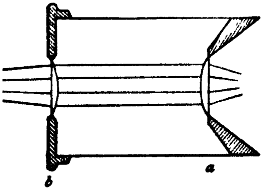

FIG. 5.

An Huygenian, or negative, eyepiece is equivalent to

a single lens of a focal length equal to twice the product of the focal lengths of the component lenses divided by their sum. A positive eyepiece is equivalent to a single lens of a focal length equal to the product of the focal lengths of the component lenses divided by their sum, minus the distance between them. In the achromatic refractor, the magnifying power of the instrument with a given eyepiece is expressed by the ratio of their focal lengths. In other words, the power of a given eyepiece is ascertained by dividing the focal length of the object glass by the focal length of the eyepiece.

It is highly important that the observer know, with as great accuracy as possible, the powers of each of the eyepieces of his telescope. This may be accomplished in several ways. The focus of a single lens equivalent to the compound one in question may be calculated by one of the foregoing rules, and the focal length of the object glass be divided by that of the equivalent single lens, the quotient giving the magnifying power of that eyepiece with that object glass. It is not very easy, however, to determine the focal length of small lenses. A better method is as follows : Focus the telescope accurately on a distant object, and then direct the tube toward the sky. On looking at the eye-lens of the eyepiece it will be seen that the image of the object glass is projected thereupon as a small luminous disk. Let the diameter of this disk be accurately measured ; and then divide the diameter of the object glass by that of the luminous circle, and the quotient will give the magnifying power.

The measurement of this tiny circle is by no means easy, especially with eyepieces of high power. It may be accurately effected with a Ramsden dynamometer or dynameter, or the simple and precise little Berthon dyna-

mometer made by Horne, Thornthwaite & Wood, of London, and sold for ten shillings. The measurement may be made with tolerable accuracy by looking at the disk on the eye lens with a small magnifying glass, taking its diameter by means of a pair of compasses, and measuring the distance between the points on a fine and accurate scale.

Modern eyepieces, however, are usually marked with their equivalent focal length, and the power of each with a given object glass is easily ascertained.

A most important question is as to the power which may be used upon any object glass. The common rule is that the very highest power which a good telescope will bear under the most favorable atmospheric conditions is one hundred for every inch of aperture. This is doubtless correct ; but both of the conditions mentioned in connection with it must be present. The range of powers for practical work under ordinary circumstances may be much better deduced from the following table, from Chambers's *Astronomy*, p. 724 :

APERTURES OF

2 in.	3 in.	4 in.	5 in.	6 in.
15	20	25	30	35
45	55	65	85	85
100	110	140	170	160
	200	300	280	250
			420	360
				500

Every telescope, however, should have one eyepiece of the highest power that the object glass will bear, for the examination of close double stars, etc., under favorable circumstances.

As regards the limit of vision of achromatic telescopes,

Mr. Chambers gives the following rule, based on Argelander's scale of magnitudes:

Multiply the logarithm of aperture in inches by 5, *and add* 9.2 *to the result.* This will give the magnitude of the smallest star visible with that aperture.

For instance, to find the magnitude, according to Argelander's scale, of the smallest star visible in a telescope of three inches aperture:

Log. 3, . .	0.477121
	5
	2.385605
Add, . . .	9.2
Mag., . .	11.58

By this rule an aperture of two inches may be expected to show a star of magnitude 10.7; one of four inches, 12.2; one of five inches, 12.6; and one of six inches, 13.09, according to Argelander's scale. The rule is based on the assumption that a star of magnitude 9.2 is the smallest which can be seen by the average observer with a one-inch telescope.

Chambers gives a modification of this plan by Mr. N. Pogson, of Madras, which is more accurate for the individual observer and a given telescope than the above. Determine by trial the smallest star, according to Argelander's or Radcliffe's scale, which you can see with an aperture of one inch. Then the limit of vision with any other aperture will be: One-inch limit $+ 5 \times$ log. aperture. Mr. Pogson observes that the limit of vision in different observers using one inch of aperture will differ less than people imagine, averaging about $9\frac{1}{4}$.

It must be distinctly understood that the above rules only refer to isolated stars, or those in a field containing only

stars not greatly exceeding the test-star in magnitude. The magnitude of the companion of Rigel (β Orionis), for instance, is 9, and so it should be visible in a one-inch telescope; but the glare of the primary star will completely overwhelm the feeble light collected from the companion by the object glass, and the little star will be absolutely invisible. This fact must be carefully borne in mind in trying double stars.

Argelander's scale of magnitudes has been referred to in connection with the foregoing rules concerning the limit of vision. In the star-lists given in this book, Smyth's scale is used. Struve's scale is perhaps the most generally accepted. The following table will show at a glance the corresponding magnitudes in each of these scales (G. Knott):

Table of Comparative Magnitudes.

Smyth.	W. Struve.	Argelander.
6	5.7	5.9
6.5	6.3	6.4
7	6.5	6.8
7.5	6.9	7.5
8	7.4	8
8.5	7.9	8.6
9	8.3	9
9.5	8.9	9.4
10	9.3	9.4
11	10	10
12	10.4	10.6
13	10.7	11.2
14	10.9	11.8
15	10.9	12.4
16	10.9	13

The magnifying of celestial objects is by no means the sole purpose of the telescope ; the collection of light from them is an equally important function of the instrument, and, in the case of the nebulæ and clusters, the more important function. When an object is looked at with the naked eye, the retina receives only so many rays as can fall upon the pupil of the eye ; but by the use of the telescope as many rays can be brought to the retina as fall upon the entire object glass. "The pupil of the human eye in its normal state has a diameter of about one-fifth of an inch, and by the use of the telescope it is virtually increased in surface in the ratio of the square of the diameter of the objective to the square of one-fifth of an inch." * Thus, to ascertain the light-collecting power of an objective, we divide the square of the diameter of the object glass by the square of $\frac{1}{5}$; or, what is the same thing, we multiply the square of the diameter by 25 ; and the quotient or product, as the case may be, will give the light-collecting power of the object glass as compared with that of the naked eye.

By the *defining* power of an objective is meant its capacity for separating closely adjacent points of visible matter. By its *illuminating* power is meant its capacity for exhibiting very faintly lighted objects. The defining and illuminating power of a given object glass of any given aperture depends upon its focal length. Should the focal length be very short, its definition will be inferior but its illumination good, a fact which is utilized in the comet-seeker. Should the focal length, on the contrary, be excessive, the definition will be good, but the illumination poor. Moreover,

* Newcomb and Holden, *Astronomy*, p. 56.

the greater the focal length, the smaller is the field of view, and *vice versâ*. A focal length which furnishes for any given glass the maximum of both defining and illuminating power is fourteen or fifteen inches for every inch of aperture.

CHAPTER II.

TESTING THE OBJECT GLASS.—EYEPIECES.—TUBES.

THE figuring of a telescopic objective is one of the most difficult and delicate operations in the arts, especially when its diameter exceeds five or six inches.* This being the case, it is to be expected that the making of the highest grade of object glasses should remain, as it does, in the hands of a few artists of the highest intelligence and skill. The manufacture of perfectly homogeneous glass for this purpose is also a difficult operation. The result of these facts is that object glasses of the first class must necessarily be expensive instruments. An estimate (although so rough as to be of little use) of the cost of a high-grade objective may be formed by a rule given by Professor Newcomb : multiply the cube of the aperture in inches by $1 and also by $1.75 ; the products will give the minimum and maximum respectively of the probable price. A first-class three-inch glass, according to this rule, would cost from $27 to $47.25 ; a four-inch from $64 to $112, and so on. I will give, however, in another place, the actual prices of object glasses as supplied by some of the best opticians of England and the United States.

In testing an objective it should be first carefully examined in its cell. It should appear brightly polished

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* On this subject see a most interesting article by Professor Newcomb, "The Story of a Telescope," in *Scribner's Monthly* for 1873, vol. vii. p. 44.

and free from scratches, and *preferably* without bubbles or sand-holes. These things, it is truly said, only cause the loss of a little light, and are not incompatible with satisfactory definition ; but the possessor of a small telescope can ill afford to lose any light. Still, these faults are not sufficient by themselves to warrant the rejection of an object glass. But *striæ*, or waves, and unequal density of different parts of the glass are most serious defects.

The telescope being fully mounted and ready for use, the object glass should be given the following tests :

1. As to whether the chromatic aberration has been corrected.

Point the telescope toward Jupiter or the moon, using in the latter case the lowest power, and focus carefully. Now, if on pushing in the eyepiece a purple ring appears around the edges of the disk, and on drawing it out, a green one, then the chromatic aberration has been corrected, since these are the central colors of the secondary spectrum, appearing where they should.

2. As to whether the spherical aberration has been corrected.

Point the telescope toward a star of moderate brilliancy, say of the third magnitude, and focus carefully. Cover the object glass with a piece of cardboard in which has been cut a circular aperture of a diameter equal to one-half that of the object glass, in such a manner that the glass and the opening in the cardboard shall be concentric. If on now looking through the telescope we find the star still in focus, the spherical aberration has been duly corrected. If, however, the eyepiece has to be pushed further in to obtain a true focus, then the spherical aberration has been over-corrected ; while if it has to be drawn further out, this aberration has been under-corrected.

The following valuable remarks are from the Rev. T. W. Webb: *

"The image should be neat and well defined with the highest power, and should come in and out of focus sharply; that is, become indistinct by a very slight motion on either side of it. A proper test-object must be chosen; the moon is too easy; Venus too severe, except for first-rate glasses; large stars have too much glare; Jupiter or Saturn are far better; a close double star is best of all for an experienced eye; but for general purposes a moderate-sized star will suffice; its image, in focus, with the highest power, should be a very small disk, almost a point, accurately round, without 'wings' or rays or mistiness or false images, or appendages, except one or two narrow rings of light, regularly circular, and concentric with the image; and in a regularly dark field; a slight displacement of the focus either way should enlarge the disk into a luminous circle. If this circle is irregular in outline, or much brighter or fainter toward the centre, or much better defined on one side of the focus than the other, the telescope may be serviceable, but is not of high excellence. The chances are many, however, against any given night being fine enough for such a purpose, and a fair judgment may be made by day from the figures on a watch-face, or a minute white circle on a black ground, or the image of the sun on a thermometer bulb placed as far off as possible. An achromatic, notwithstanding the derivation of its name, will show color under high powers where there is much contrast of light and darkness. This 'outstanding' or uncorrected color results from the want of a perfect balance between the optical properties of the two kinds of glass of which the

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* *Celestial Objects for Common Telescopes*, p. 3.

object glass is constructed ; it cannot be entirely remedied, but it ought not to be obtrusive. In the best instruments it forms a fringe of violet or blue round luminous objects in focus under high powers, especially Venus in a dark sky. A red or yellow border would be bad ; but before condemning an instrument from such a cause, several eyepieces should be tried, as the fault might be there, and be easily and cheaply remedied."

The "wings" spoken of in the above extract may be due to several causes. They may arise from the object-glass lenses having been screwed too tightly together, and the fault may be corrected by *very slightly* loosening the screw-cell in which they are placed. This cause, however, is an uncommon one. A much more usual cause lies in the objective's not being in every part of uniform refractive power—a very bad and virtually incurable defect. The defective portion may indeed be covered up with an opaque screen, and thus, perhaps, fair definition be secured at the expense of light ; but the better course is to reject peremptorily any glass which has not in every part the same refractive power.

These "wings" may also be due to the fact that the object glass is not set at right angles with the optical axis of the telescope ; a fault which would be quite unpardonable in the work of an optician, and which could easily be avoided by proper care in that of an amateur. They may also be caused by a slight inclination of the eyepiece. This may be detected by covering each of the glasses of the eyepiece with a circular cardboard screen pierced in the centre with a small aperture, and covering the object glass with a similar pierced screen. If the eyepiece is correctly centred, it will be possible to see through the three openings at once.

If the tube of the telescope is not somewhat greater in diameter than the object glass, a particular form of "wing" may be seen extending upward from a star like the tail of a little comet, when the instrument is used in the open air. This is most apt to be the case when the tube is of wood, and the amateur who makes his own telescope needs to be warned of the danger. The cause of this annoying defect, which once nearly caused the rejection by Alvan Clark of one of his own earlier object-glasses as worthless,* is that a wooden tube under the cold sky radiates heat from its upper surface and at the same time receives warmth from the earth under it. The result is that a thin layer of warm air lies at the bottom of the tube, and an equally thin layer of colder air exists at the upper surface. This causes a slight upward refraction of the rays which pass through the outer edges of the object glass, and thus produces the comet-like tail. The remedy or preventive is to make the tube of sufficient diameter to bring the layers of warm and cool air out of the path of the rays, or to cover the tube with tinfoil, which, by its inferior radiating power, will prevent the trouble in question.

According to Dawes † (one of the highest of authorities on the telescope), the severest test of figure for an achromatic objective is the similarity of the image of a bright star, viewed with the focus too long, to the same image viewed when the focus is to an equal linear extent too short; the amount of the dissimilarity being a measure of the imperfection of the instrument.

The examination of stars out of focus is an important

* See Professor Newcomb's article, before referred to.

† Chambers, p. 617.

aid in the testing of an object glass and of its mounting. I append a series of figures (from Professor Newcomb) giving the appearance of spectral images of stars in different telescopes, with the focus imperfect through the pushing in of the eyepiece, and of the same images with the focus imperfect through the drawing out of the same.

There is, to a practised eye, no better test of the character of an object glass than the image formed by it of a star of the third or fourth magnitude. A bright little disk surrounded by from one to three delicate thread-like concentric rings (called, technically, diffraction rings) proves pretty conclusively the general excellence of the object

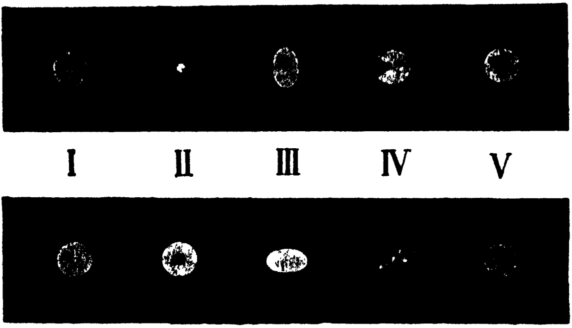

FIG. 6.

I. Images as they should be.
II. Spherical aberration shown by the light and dark centres.
III. Objective not spherical but elliptical.
IV. Glass not uniform—a very bad and incurable case.
V. One side of objective nearer than other. Adjust it.

glass. I give below two figures by Captain Noble, the first showing what a star-image ought to be, and the second showing, with an almost comic truthfulness, what it sometimes is, but most emphatically ought not to be.*

The sharpness of this image should be, in a good telescope, seriously deranged by a movement of the eye piece to the extent of one-tenth of an inch either way. If this movement makes but little change, the object glass is not all it ought to be.†

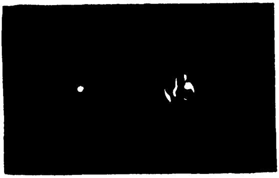

FIG. 7. FIG. 8.

It will be well for the tyro to get an experienced telescopist to make the foregoing tests for him, if the services of such a one can be commanded The following remarks ‡ by Sir Howard Grubb, of the great Dublin firm of telescope-makers, are full of truth and humor, and are commended to the reader's careful attention. Especially are the observations as to the necessity of a certain education of the eye for telescopic work to be diligently noted :

"It is almost impossible to give any directions which will enable a tyro to detect whether his telescope is good or not. It would be about as hopeless a task as to try to convey to a person wholly uneducated in art, and who had never seen anything but daubs, how to know a well-painted picture. One great mistake which beginners fall

* The diffraction rings in these figures are necessarily represented as much thicker than they are in reality.

† Chambers, p. 617.

‡ See Oliver's *Astronomy for Amateurs*, p. 29.

into, and which, it is to be feared, most text-books rather encourage, is that of supposing that, because a telescope of a certain size should divide such a star, the telescope is necessarily bad because, when he puts his eye to it, he does not see it so divided. 'The most important part of the telescope is the man at the small end,' said a celebrated astronomer. There is such a thing as education of the eye, and even though a person have good, sharp, ordinary eyesight, it by no means follows that he will see nearly as much with a telescope at first as a person of very ordinary sight who has educated his eye by experience.

"Text-books on the subject, by giving lists of objects which are capable of being divided by different sized telescopes, and pictures (?) of planets, etc., as they should be seen, rather encourage the mistake.

"An enthusiastic amateur receives a telescope he has been waiting for for months; meanwhile he has studied up the text-book on the subject, and he finds that a telescope of the size of his should have a power of x, and divide such and such stars. The moment he gets his instrument into position he puts on his highest eye piece and points to these objects, and great is his disgust to see something like a ball of cotton wool on a flaming gas-lamp. He is not told that this object can be so seen under favorable circumstances and with *educated eyes*, or that the beautiful pictures he sees of Saturn and Jupiter are either the result of a number of observations, or what was seen on some exceptional occasion, and he condemns at once what in experienced hands may prove an excellent instrument. An experienced observer judges of a telescope not so much by trying what stars it will divide, as by the appearance of any particular stars which he is familiar with."

The observer may test his telescope for definition and illumination by the *following objects, suggested by* Mr. Lockyer :

A 2-inch telescope with powers of from 60 to 100 should exhibit :

Polaris,	γ Arietis,	α Geminorum,
α Piscium,	ρ Herculis,	γ Leonis,
ν Draconis,	ζ Urs. Majoris,	ζ Cassiopeæ.

A 4-inch with powers of from 80 to 100 should exhibit:

β Orionis,	α Lyræ,	δ Geminorum,
ϵ Hydræ,	ϵ Leonis,	σ Cassiopeæ,
ϵ Bootis,	γ Ceti,	ϵ Draconis.

Different eyes and telescopes, however, will give very different results upon the above stars. γ Leonis, for example, would be a very severe test for a 2-inch ; while β Orionis and ϵ Bootis have often been seen with a 3-inch and with even smaller apertures.

Concerning eyepieces there is little to be said. The construction of them, while by no means so easy as to greatly tempt the amateur to make them for himself, since very accurate adjustments are required in them, is still within the power of an ordinarily skilful optician, and they are consequently easy to obtain and comparatively inexpensive, their prices ordinarily ranging from $4.50 to $8.00. The Huygenian form, or one of its modern modifications, will of course be employed, unless the observer desires to make use of a micrometer, which, it must be understood, is practically out of the question for any telescope unprovided with a driving-clock.

The materials used for telescope tubes are wood, brass, steel, or a species of *papier-maché* for instruments up to

three or four inches of aperture; wood or brass for the next series, and frequently sheet-iron or steel for the largest sizes. Our observer's telescope will probably have a tube of brass—possibly steel—if purchased in a complete form. Should he construct his own telescope, the question as to the material of the tube will be an important one. Wood is apt to split; brass is very expensive. A tube made by pasting alternate layers of card and calico over a wooden mould, which is then withdrawn, is said by Mr. Proctor to be both light and strong. This form of tube is excellently adapted for telescopes up to two and one-half inches of aperture, but for anything larger another plan suggested to Proctor by Mr. Sharp, of St. John's College, Cambridge, is greatly to be preferred. This is to have the tube made of tin, covered with layers of brown paper, well pasted and thicker towards the middle of the tube. This, according to Mr. Sharp, forms a light and strong telescope tube, almost wholly free from vibration. I strongly recommend this plan as cheap and effective.

The inside of the tube must be colored dead black to prevent the reflection of any light from it. The following is the best composition for this purpose: Lampblack, five parts; finely pulverized gum-arabic, two parts; brown sugar, one part. Mix to a thick paste with water, and apply with a piece of flannel. Two coats may be necessary. The proportions should be carefully preserved, since if there is too much lampblack the composition will rub off, while if there is too little it will reflect light.

The above mixture adheres readily to wood or paper, but not very well to metal. A tin tube may be lined with brown paper previously blackened with the compound. Brass may be blackened by means of a solution of one drachm platinum bichloride and one grain nitrate of silver

in one and one-half ounces of water. The brass is first thoroughly cleaned and then warmed, and the solution is applied with a tuft of cotton. Rub till dry, and finish off with a little powdered graphite, taking care not to rub this latter so as to produce a polish. (M. Carey Lea.) A much cheaper and equally effective way of blackening brass is to clean it thoroughly and immerse it for ten minutes in a ten per cent. solution of potassium sulphide. The metal is then washed in water and dried, and will be found to be thoroughly and permanently blackened.

It is necessary, for reasons mentioned on page 20, to have the tube somewhat larger than is required for the admission of the object-glass. "Stops" or diaphragms pierced with apertures to transmit all the rays except those falling through the extreme edges of the objective, are usually placed in the tube, and serve to cut off the "ragged edge" of the field of view, and as an additional protection against light reflected from the interior of the tube. I have never found these stops necessary if the inside of the telescope is thoroughly blackened. The amateur who has a telescope made under his own supervision, or who makes it himself, must be particularly careful that the ends of the tube are cut squarely at right angles with its length, to insure the proper centring of all the lenses; in fact, the ends had better be "trued" in a lathe.

The eyepieces slip into a tube at the eye end of the telescope, which is capable of motion back and forth for the adjustment of the focus. This movement is usually, and should be always, effected by means of rack-work. The focusing apparatus should work smoothly and closely and with as little "back-lash" as possible; *i.e.*, when the movement of the button is reversed, the reverse

motion of the eyepiece should begin at once, without any intermediate play of the rack-work.

The construction of a telescope, aside from its optical parts, is fairly within the powers of an ordinarily skilful amateur handicraftsman. But the student may prefer to purchase his telescope complete, and it cannot be doubted that when this is possible, it is by far the best course for him to pursue.

CHAPTER III.

THE STAND.

SCARCELY less important than a good telescope is a good stand. There is not a doubt that a telescope set upon a firm and steady mounting will not only give more pleasure in its use, but will exhibit more difficult objects than a larger and perhaps finer instrument set upon a rickety, unsteady and clumsy stand. Such a mounting as the latter will be a source of endless vexation and trouble ; so let the possessor of a telescope see to it that his stand is as firm as the nature of things admits.

Small telescopes are sometimes mounted on what is known as the pillar-and-claw stand : an upright pillar supported upon three feet. A more usual and much more convenient mounting is a wooden closing tripod. Telescopes mounted upon such stands are usually provided with two motions : one in *altitude*, or from the horizon to the zenith, and the other in *azimuth*, or at right angles to the first. This is known as the altazimuth stand. Several devices have been contrived to render this system of mounting convenient and reliable, among which there is nothing better than the plan described by R. A. Proctor,* and represented in Fig. 9.

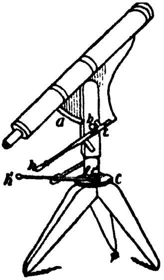

FIG. 9.

* *Half-hours*, p. 16.

"The slow movement in altitude," says Mr. Proctor, "is given by rotating the rod *h e*, the endless screw in which turns the small wheel at *b*, whose axle in turn bears a pinion-wheel working in the teeth of the quadrant *a*. The slow movement in azimuth is given in like manner by rotating the rod *h' e'*, the lantern-wheel at the end of which turns a crown-wheel on whose axle is a pinion-wheel working on the teeth of the circle *c*. The casings at *e* and *e'*, in which the rods *h e* and *h' e'* respectively work, are so fastened by elastic cords that an upward pressure on the handle *h*, or a downward pressure on the handle *h'*, at once releases the endless screw or the crown-wheel respectively, so that the telescope can be swept at once through any desired angle in altitude or azimuth. This method of mounting has other advantages: the handles are conveniently situated and constant in position; also, as they do not work directly on the telescope, they can be turned without setting the tube in vibration." But Mr. Proctor continues: "I do not recommend the mounting to be exactly as shown in the figure. That method is much too expensive for an altazimuth. But a simple arrangement of belted wheels in place of the toothed wheels *a* and *c* might very readily be prepared by the ingenious amateur telescopist; and I feel certain that the comfort and convenience of the arrangement would amply repay him for the labor it would cost him. My own telescope—though the large toothed wheel and the quadrant were made inconveniently heavy (through a mistake of the workman who constructed the instrument)—worked as easily and almost as conveniently as an equatorial."

The observer with an altazimuth is compelled to search for every object which is not visible to the naked eye, by

the aid of directions as to the situation of the object with reference to visible stars. Great pains have been taken in the lists of celestial objects given in this book, to make these directions full and accurate; but it must be admitted that in many cases patience and time are required to "pick up" the object. Still, this is the only course open to the telescopist whose only means of observation is an altazimuth, or even an equatorial without graduated circles; and this is the class of observers for which this book is principally prepared. But should the amateur be fortunate enough to be able to provide himself with an equatorial mounting with graduated circles, he is at once placed beyond the necessity of "fishing" for objects, to use Admiral Smyth's expressive phrase, since he can at once direct his telescope to the desired place.

As the equatorial mounting is incomparably superior to all others, and is the one almost invariably employed by professional astronomers for extra-meridional telescopic work, every student of the telescope should be acquainted with its principles and the method of using it. It consists essentially of an axis placed parallel with the axis of the earth, with another axis set at right angles to it. The first of these is called the *polar* axis, the second the *declination* axis. At one end of the declination axis, and at right angles to it, is fixed the telescope, and at the other a weight to counterpoise the telescope. As all celestial objects appear to move in circles about the pole of the heavens, it is evident that if the polar axis of a telescope mounted as above be caused to rotate in a direction the same as that of the apparent motion of the stars, and at the same rate, it will continue to point to any star to which it may be directed, as it describes its course in the sky. If a telescope mounted on an altazi-

muth stand be tilted so that its previously upright standard points to the pole of the heavens, or, in other words, is parallel with the earth's axis, it is plain that by pointing the instrument at any given star, and rotating the standard in a direction contrary to that of the earth's diurnal motion, and at a corresponding rate, the telescope will follow the star. This would be an equatorial in its simplest form.

The place of a star or other object is located upon the celestial sphere in the following manner: First, by its distance, reckoned on the celestial equator, from the vernal equinox, or as it is frequently called, the First Point of Aries. This is called its *Right Ascension*, and is usually expressed in hours, minutes, and seconds, but sometimes in degrees, minutes, and seconds; the equator being divided into twenty-four hours or three hundred and sixty degrees. Second, by its angular distance north or south from the equator, measured on the great circles passing through the poles. This is called its *Declination*, and is invariably expressed in degrees, minutes, and either seconds, or, more frequently, decimals of minutes. Sometimes the second co-ordinate is stated in North Polar Distance—a phrase which explains itself.

Now, if the polar axis of an equatorial be rotated, the end of the telescope will describe circles parallel with the equator; and if the declination axis be rotated, the end of the telescope will describe great circles passing through the poles. It is evident, then, that if properly graduated circles be attached to these two axes, the right ascension and declination of any object to which the telescope is pointed may be easily ascertained; and, conversely, if the right ascension and declination of any object are known, the instrument may be readily directed to it.

Fig. 10 represents a portable equatorial stand. It will be noted that an arrangement is provided for setting the polar axis parallel with the axis of the earth, according to the latitude of the place in which the instrument is

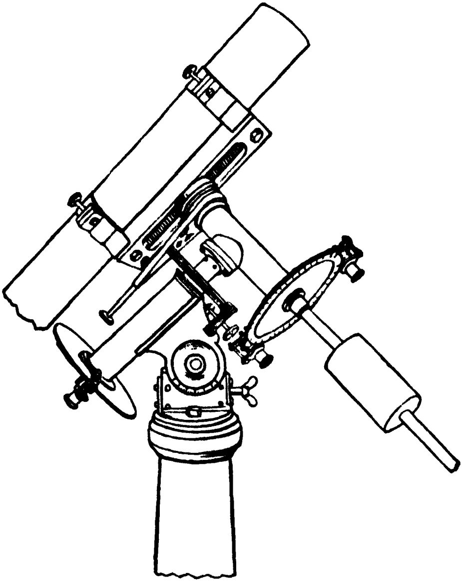

FIG. 10.

used. In large fixed stands for observatory use, the position of the polar axis is permanently fixed by the maker. Verniers are provided for setting and reading the circles, and sometimes small microscopes for more conveniently examining them.

In using the equatorial, the stand must be placed in such a manner that the polar axis is parallel with the axis of the earth; that the declination circle shall read 0° when the telescope points to the celestial equator; that the polar axis shall be in the meridian; and that the index of the right ascension or hour-circle shall read 0° when the telescope is placed in the meridian. In scientific observation these adjustments must be made with great accuracy, and the reader is referred to any work on practical astronomy for the methods employed. A portable equatorial, however—unless the student is fortunate enough to possess a fixed observatory—will have to be adjusted for each evening's observation, and minute accuracy is hardly practicable, but the observer can with but little trouble arrange his stand with sufficient correctness for an amateur's purposes. This is accomplished as follows:

Set the instrument approximately in the meridian by means of a compass or by reference to the pole-star. Fix the tripod firmly, so that the base of the equatorial shall be level. The following adjustments must then be made: *

1. *To set the polar axis parallel with the earth's axis.*

Some portable equatorials possess a graduated scale by which the adjustment may be made with tolerable accuracy if the base of the stand be perfectly levelled. If this be wanting, the adjustment is effected as follows: Choose some star whose position is known and which is at once near the meridian and near the zenith. Point the telescope to it and read the declination circle; then turn the polar axis half round, the telescope still bearing on the

* Chambers' *Astronomy*, pp. 653–657.

star, and again read the circle. Add the two readings and divide by 2, which will give the mean observed declination. If the star is not near the zenith, correct this mean declination for refraction. Compare the observed declination with the true declination given by the catalogue. If the observed declination exceeds the true, the pole of the instrument is above the pole of the heavens, and *vice versâ*, and must be adjusted accordingly.

2. *To make the index of the declination circle point to* 0° *when the telescope points to the celestial equator.*

Take the difference of the two readings obtained in the first adjustment, and divide it by 2; this will be the index error of the declination verniers, and they must be moved to correct it unless the error is extremely small, when it had better simply be allowed for in observation.

3. *To set the polar axis in the meridian.*

Point the telescope to some known star about six hours east or west from the meridian and as nearly midway as possible between the pole and the horizon. Read the declination circle (correcting for refraction if practicable, although this is hardly necessary for an amateur's purposes, unless great accuracy is desired), and compare the result with the value assigned in the latest catalogue accessible. If the star is east of the meridian, and its observed declination *exceeds* that given in the catalogue, the lower end of the polar axis will be to the west of its true place and must be moved accordingly. Should the observed declination be *less* than that given in the catalogue, the lower end of the polar axis is to the east of its true place.

Should the star observed be west of the meridian, the effects of the erroneous position and the adjustments for correcting it will be reversed.

4. *To make the index of the hour-circle point to 0° when the telescope is in the meridian.*

If the foregoing adjustments have been carefully made, this last one will be found to have been involved in them. The declination axis may be set horizontal by means of a level, and the verniers of the hour-circle set to zero.

There are two methods of using the equatorial. In the first, a clock or watch set to sidereal time is necessary. Any clock may be made to serve this purpose for the amateur, the difference between the rate of a clock keeping sidereal time and one keeping mean time being of little moment in one evening's work. The student may, however, regulate his clock to sidereal time, if he choose, by causing it to gain 3m. 55s. in twenty-four hours. Before beginning observations the clock should be set to sidereal time in the following manner: Turn the adjusted telescope to some known star east of the meridian, and read on the hour-circle its distance from the meridian. Subtract this reading from the star's right ascension, and the result will give the sidereal time with sufficient accuracy for our purpose, and the clock may be set to mark it. Of course, the student will remember that a sidereal clock indicates twenty-four hours to the day, while a mean-time clock indicates twice twelve. If the sidereal time exceeds twelve hours, the observer may simply subtract twelve from it and set his clock accordingly.

In case the star used in setting the clock is west of the meridian, the circle reading is to be *added* to the right ascension of the star to obtain the sidereal time.

Of course, in all these observations for adjustment, etc., the telescope is to be pointed toward the star so that the latter shall appear in the centre of the field. This is most conveniently accomplished by the aid of a positive

eyepiece with crossed wires in its focus; but this is not necessary.

Let us take an illustration of this method of using the equatorial. Suppose we wish to find the superb red star R Leporis. We find from our catalogue that the right ascension of this star is 4h. 54m. 36s., and its declination 14° 58.2′ south; and we will suppose that our clock indicates 6h. 56m. sidereal time. Since the right ascension of the star is greater than the sidereal time (which expresses the right ascension of any object at that instant on the meridian), we see that the star has not yet reached the meridian. Accordingly we subtract the sidereal time from the right ascension of our star, and find that the latter is 2h. 1m. 24s. east of the meridian. This is called the *hour angle*. The telescope is now turned to the east and set to indicate this distance from the meridian on the hour circle. Then setting the declination circle to 14° 58.2′ south, the star should be seen in the field.

If the right ascension of an object be less than the sidereal time, it is evident that the object is west of the meridian, and the hour angle will be found by subtracting the right ascension from the sidereal time.

The second method of using the equatorial is simpler and more convenient for the amateur, inasmuch as no clock is required, although it involves, perhaps, a little more trouble in circle-reading. Select some known star visible to the naked eye, and note the difference between its right ascension and that of the required star. If the right ascension of the known star is greater than that of the required star, the latter will be west of the former, and *vice versâ*. Direct the telescope to the known star, and read the hour circle. Now move it east or west, as the case may be, until the index of the hour circle has

measured an arc equivalent to the difference of right ascensions. Set the declination circle, and the required star should be found in the field. It will be found best to select the known star on the same side of the meridian as the required one, as the reading of the hour circle will be less troublesome.

If the equatorial be not provided with a clamp in right ascension (*i.e.*, to the polar axis), it will usually be well to set and clamp the telescope in declination before turning it on its polar axis.

The success of observations with the equatorial will depend on the accuracy with which the adjustments have been made, and it is always best with a portable equatorial to put on the lowest power when seeking an object, so as to embrace as large a field as possible. A little practice and care will enable the observer to adjust his equatorial expeditiously and with sufficient accuracy for an amateur's purposes. A star may be followed with an equatorially mounted telescope by simply turning the instrument on its polar axis. An equatorial stand is usually provided with an appliance to give this slow movement in right ascension, consisting of a crown or lantern wheel working upon the polar axis and provided with a universal joint from which a rod leads to the observer's hand. In the more elaborate and expensive equatorial stands, clock-work is provided to move the telescope in right ascension at a rate corresponding to that of the apparent motion of celestial objects.

The prices of portable equatorial stands are given elsewhere, but the amateur will find a description of a simple stand, which he can make himself, or have constructed under his own supervision, in the *Astronomical Register*, vol. xiv., p. 35. A common equatorial may be made much

more effective by having attached to it plain metal circles or even stout pasteboard ones, graduated by the observer himself. The student who is acquainted with the exquisite graduation of modern astronomical circles may feel dismayed at the suggestion of graduating circles for himself ; but I can assure him that with patience and care he can prepare circles which, if they will not enable him to hit exactly upon an object, will greatly help him in finding it.

CHAPTER IV.

ACCESSORIES OF THE TELESCOPE.

THERE are but few of the supplementary instruments used in modern astronomy which are applicable to a small telescope without clock-work to drive it. Micrometric measurements, celestial photography, and, except in a very limited degree, spectroscopic work, must be left to those fortunate ones who possess telescopes of larger size and more perfect mounting than the average amateur can procure. There are two accessories, however, which every telescope should possess. These are a finder and a dew-cap. When observing with high powers, it is a matter of very considerable difficulty to fix the telescope upon any object. Practice will diminish the difficulties of this operation, but not sufficiently to prevent the task's being tedious and vexatious. The *finder* relieves this trouble at once. It is a small telescope of low power, and consequently of large field, attached to the telescope at its eye-end, and parallel with it. It is so adjusted that any object to which the telescope is pointed will appear at once in the centre of its field and that of its finder. To fix the telescope upon any object, all we have to do is to set the instrument so that the object is visible in the centre of the finder's field, which is effected with the greatest ease, and then, if the adjustments have been properly made, the star will be seen in the centre of the telescope's field, no matter how high may be the power of the eyepiece.

The place of an object invisible to the naked eye or in

the finder is often given by its position with reference to certain visible stars. It frequently happens that these guiding stars may be visible in the finder, and the telescope may be readily set to the proper point by the aid thus afforded.

The amateur need go to little expense to secure a finder amply sufficient for his needs. A telescope of my own is fitted with a small toy "spy-glass" costing fifty cents, which serves its purpose as a finder to perfection. Mr. Proctor suggests* that the amateur may make his own finder by fastening on the two ends of a pasteboard tube two lenses at a distance from each other equal to the sum of their focal lengths, the object glass of, say, six or eight inches focal length, and the eye-lens of one or two, giving a power of from three to eight, according to the lenses used. This little contrivance is fastened to the telescope tube with wires and adjusted each night before beginning observations, by first bringing a star to the centre of the telescope's field with a low power, and then setting the finder so that the star appears at the same time in the centre of its field. "A card tube with wire fastenings," says Mr. Proctor, "such as we have described, may appear a very insignificant contrivance to the regular observer with his well-mounted equatorial and carefully adjusted finder. But to the first attempts of the amateur observer it affords no insignificant assistance, as I can aver from my own experience. Without it—a superior finder being wanting—our 'half-hours' would soon be wasted away in that most wearisome and annoying of all employments, trying to 'pick up' celestial objects."

Another necessity to the telescopist who makes out-

* *Half-hours*, p. 20.

door observations is a dew-cap. Glass is an excellent radiator of heat, and the atmosphere quickly deposits dew upon it—an effect from which an object glass needs protection. The dew-cap is a device to afford this protection, and is furnished regularly by some makers with every telescope. It consists of a tube of metal or pasteboard blackened inside and placed over the objective end of the telescope so as to project from eight to twelve inches beyond the object glass. The amateur can easily make this for himself and should invariably use it when observing out of doors.

An instrument known as the diagonal eye-tube is sometimes used for observing objects at high altitudes. This consists of two tubes set at right angles with each other and containing at the elbow either a reflector of speculum metal or, what is infinitely better, a right-angled prism.

The rays from the object are reflected (with great loss of light) from the mirror at *AB*, or (with scarcely any loss of light) from the longest side of the right-angled prism *ABC*, and viewed by the eye-piece at *D*, in the usual manner. The diagonal *eye-tube* is not to be confounded with the diagonal *eye-piece*, in which the change of direction of the light is accomplished between the lenses of the eye-piece.

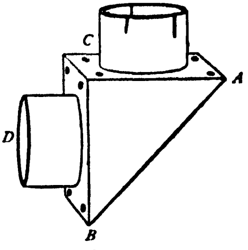

FIG. 11.

This contrivance will be found very useful for observing objects near the zenith, or indeed at any elevation above fifty or sixty degrees.

CHAPTER V.

THE CARE OF THE TELESCOPE.

As a valuable and delicate instrument the telescope demands, and should receive, the most solicitous care. In particular does the object glass require the most tender treatment. It should be kept covered with its cap whenever it is not in actual use; the dew-cap should never be forgotten; and the glass should never be brought from a cold into a warm atmosphere without first covering it to prevent its becoming bedewed. If the damp gets between the glasses it will produce a fog—a *sweat*, in optician's language—and, according to Proctor, even a seaweed-like vegetation, by which a valuable glass may be ruined. Should any moisture unluckily get upon the object glass, the telescope must be put in a warm place until the enemy has fled.

When it is necessary to clean the object glass—and it should only be touched when cleaning *is* necessary—a soft camel's-hair brush should first be used for removing the coarser particles of dust, which may be followed by a very careful sweeping with either a piece of very fine clean chamois-skin, or, better still, an old soft silk handkerchief. Mr. Chambers prefers an old but fine cambric handkerchief. Mr. Franks recommends soft tissue paper aided by the breath. A little space near the edge of the glass is first cleaned, and from that point the dust is gently swept away. But let it be noted that a few specks of dust are of much less moment than irremediable scratches, and

polished optical glass scratches very easily. Should any "refractory stains" get upon the object glass, they may be removed by a few drops of alcohol on perfectly clean absorbent cotton ; but, as Mr. Chambers dryly observes, a careful observer will never allow any refractory stains to get upon his object-glass. Should fine dust ever cake, as it sometimes will, upon the glass, breathe on it and wipe very gently from the edges with a soft cloth, which is then thrown away. This may sound alarming, but it is the precept of no less high an authority than Sir Howard Grubb.

Everything used for cleaning lenses should be kept in a tightly closed box when not in use, to preserve it from dust.

Never touch the polished surface of any lens with your fingers. The insensible perspiration, always present in small quantities, appears to have a corroding effect upon optical glass, and will destroy its polish.

All of the foregoing remarks as to cleaning lenses apply to eyepieces as well as to object glasses. Particularly must it be remembered that every scratch or speck on the field-glass of a negative eyepiece will appear in a magnified form on looking through the eyeglass. Eyepieces should be kept, when not in use, in a dust-tight box ; one provided with compartments is by far the best.

Under no circumstances should the two glasses composing the objective be separated or taken out of their cell by the amateur. Should circumstances make it necessary to separate them, let it be done by the maker or by a competent optician : otherwise the glass may be rendered worthless. Another rule, with an example, is given by Mr. Proctor, which I will quote in his own vigorous language : "Suffer no inexperienced person to

deal with your object glass. I knew a valuable glass ruined by the proceedings of a workman who had been told to attach three pieces of brass round the cell of the double lens. What he had done remained unknown ; but ever after a wretched glare of light surrounded all objects of any brilliancy."

Should the brass-work of the telescope or stand become dull or dirty, it may be cleansed with a piece of chamois-skin moistened with sweet-oil. Care should be taken in cleaning an equatorial stand, not to press hard upon the circles lest they be bent out of "true." For protecting bright metal surfaces from oxidation, and also for lubricating purposes, ordinary vaseline is by far the best preparation, as it is free from the gumminess which is apt to attach to common oils.

CHAPTER VI.

THE USE OF THE TELESCOPE.

THE amateur who possesses no observatory will find it by far the best plan to make all his observations out of doors. If a telescope is mounted in a house, the movement of any person about any part of the building will cause the instrument to vibrate, especially when high powers are in use. In regular observatories it is customary to mount the equatorial on a pier of solid masonry to prevent this very difficulty. Moreover, when the telescope is used at a window, the observer will be troubled greatly by a wavering of the atmosphere before the object glass. This annoyance will be considerably lessened if the temperature of the room is the same as that of the outer air, but such a condition is not easily attained.

Observations of all celestial objects, except those so near the horizon that the observer can stand upright when viewing them, should be made while comfortably seated; and this not so much for comfort's sake as for clearness of vision. There is no doubt that a constrained or uncomfortable position decidedly affects the power of the eye in telescopic work. Specially constructed observing chairs are in use in observatories, but the amateur will need only a common chair and a stool. A small but strong step-ladder will also prove useful.

I must not omit to warn the reader of the importance of being warmly clad for out-door observation in winter.

The use of the telescope involves little bodily motion; while looking through it the whole person is kept as still as possible; and the result is that a temperature which would be regarded as mild for a walk may chill the body thoroughly in a short time while at work with the telescope. A severe and perhaps dangerous cold may thus be taken. So let the observer on all winter nights, and on a very large proportion of spring and autumn ones, put on his heaviest great-coat, and if the ground be at all damp, overshoes as well. I wish to impress the student with the importance of these precautions.

Should artificial light be needed for consulting a book or map, or for looking at the circles of an equatorial, the observer should use a bull's-eye lantern with a slide, as he is thus enabled to throw a light on the object without dazzling his eyes, and the light may be cut off with the slide when not needed. It is a good plan to cover the bull's-eye with a piece of thin red silk or red paper, since red light is less trying to the eyes than white. A very good substitute for the bull's-eye lantern is a little flat tin lantern with a red glass front and having a door by which all light may be cut off. Such a lantern is commonly sold by dealers in photographic materials.

The novice is apt to assume that a clear bright night is necessarily the best for telescopic work, but such is not always the case. Some brilliant nights, while available for good work on the nebulæ, are characterized by very poor definition, and are practically worthless for observations on the planets and double stars. This, I think, may be especially noted with regard to Saturn, whose rings I have seen go through the most extraordinary gyrations on an apparently superb night. On the other hand, a hazy night often gives very beautiful definition, especially in

the case of the planets. A remarkable instance of this is the discovery by Professor Bond of the inner dusky ring of Saturn on a night so hazy that none but the larger stars were visible to the naked eye.

Several devices are at times made use of for improving the defining power of the object glass when employed upon close double stars or other objects needing particularly good definition. One of these is to "stop down" the glass; in other words, to diminish its aperture by means of a screen of cardboard or similar material pierced with a circular opening of the desired size. This is sometimes particularly useful in observing Venus. Another device, recommended by Sir John Herschel, is to fix a disk of cardboard having a diameter of from one-fifth to one-half that of the object glass centrally in front of the glass. This will increase the separating power of the objective, and will be occasionally useful, although it increases both the number and the breadth of the diffraction rings around the image. Mr. Dawes recommends his own curious plan of covering the whole object glass with perforated cardboard such as is (or was) employed for worsted work; or, should the object be too faint to bear such treatment, with a piece of cardboard pierced with circles of equal size (about one-fifth of an inch in diameter), arranged in concentric circles.

All these contrivances may be useful at times, but as a general rule the possessor of a small telescope cannot afford to lose any light.

To get the eye in condition for use at the telescope, it is well for the observer to remain in the dark for some little time before beginning work. If after some time spent in observation it is desired to scrutinize a difficult object, it will be very useful to turn the eyes toward a

dark place, or cover them with the hand for a time, to permit the pupils to dilate. An instance of the advantages of this plan is the rediscovery by Sir John Herschel of the satellites of Uranus, which he accomplished after keeping his eyes in darkness for a quarter of an hour.*

If the stand of a telescope is at all unsteady, it is an excellent plan to point the instrument not directly on the object that is to be viewed, but a field, or even two, preceding the object, and allow the diurnal motion of the earth to carry the image across the field. This will permit the telescope to settle down into perfect steadiness before the object comes in view. The finder will afford great help in carrying out this expedient.

A word should be said concerning the focusing of the telescope. The usual method with novices is to turn the rack-button slowly until the image appears sharp. As a result it is hardly ever turned enough, and the eye is strained. The proper way is to turn the button back and forth, bringing the eye piece decidedly outside and inside of the focus each time ; and after a few turns it will be found that a certain degree of turning brings it equally on each side of the focus. Make the object equally indistinct on both sides, and give a half turn, which brings the eye piece to the true focus. Practice will speedily make perfect in this operation.†

The beginner with the telescope is very apt to make the same mistake as does the beginner with the microscope, and that is in a tendency to use too high powers. In examining very close doubles a high power must, of course, be used ; the same is true of the more minute

* Proctor. † Sir Howard Grubb.

study of the planets; but for all other observations a lower power is far better. A high power, moreover, brings out all defects in the object glass, the stand, and the state of the atmosphere; and the field is made so small that the object passes very quickly out of it by the rotation of the earth. An object sends a certain amount of light through the telescope, and magnifying any object having an apparent diameter lessens its light, since it spreads the image over a larger space. For this reason powers beyond a certain limit are perfectly useless in the examination of nebulæ. Hints as to the powers to be employed in particular cases will be given further on, and the reader is referred to Chapter I. for a table of the highest powers that should be commonly used with given apertures.

Familiarity with the constellations is, of course, a requisite of the first importance in an astronomer; and it is believed that the arrangement adopted in this book, of grouping the telescopic objects of the heavens according to the asterisms in which they appear, will conduce greatly to a full and satisfactory study of the constellations singly. A set of good star-maps is perhaps the very first book that the astronomer needs. For merely the delineations of the constellations and the relative positions of the stars, any of the standard maps will be sufficient: Hind's, in Keith Johnson's *Atlas of Astronomy*, the Royal Astronomical Society's maps, those published by the Society for the Diffusion of Useful Knowledge, and Heis's *Neuer Himmels Atlas* are all of the highest class. The well-known and inexpensive maps accompanying Burritt's *Geography of the Heavens* are also fairly good. But for locating the planets in their course,

either for purposes of study or (in the case of Uranus and Neptune) for telescopic observation, the above maps are not suited, since, owing to precession, they are out of date. I therefore recommend the student to supply himself with R. A. Proctor's admirable maps or Klein's *Star Atlas*, recently published by the Society for Promoting Christian Knowledge. This latter is a work of much value, although unsuited for consultation by lantern light, since the lettering and numbering of the stars, etc., and the names and boundaries of the constellations are printed in a faint red. Both Proctor's and Klein's Atlases are constructed for the year 1880, and will remain sufficiently accurate for our use for twenty or thirty years to come.

In studying the constellations the observer should accustom himself to estimate by the eye distances in degrees on the celestial sphere. There are three standards of measurement provided in the heavens. The length of the belt of Orion is (speaking roughly) three degrees; the distance from α to β Ursæ Majoris (the well-known "Pointers") is five degrees; and the average apparent diameter of the moon is half a degree. By practice the observer will soon acquire the power of measuring distances by these celestial measuring-rods with very considerable accuracy.

If the student is at all near-sighted (as most modern students are), he will find it very helpful and pleasant to use an opera-glass in studying the constellations. I always make use of a binocular field-glass of one and seven-eighths inches aperture and embracing a field about four degrees in diameter. The larger clusters—the Pleiades, the Hyades, Præsepe, and Coma Berenices—are peculiarly beautiful in such a glass; and no one who has not tried

this method of studying a constellation can imagine the pleasure and ease afforded by it.*

Better than star-maps for some reasons is a good modern celestial globe. With this classic instrument the student can perform many problems which are of importance to him in his astronomical work, such as ascertaining quickly and easily the time of the rising, culmination, and setting of any star or planet, and the accurate locating of any telescopic object which may not be marked upon the globe. The little machine known as Whitall's Planisphere, while of small merit as a map, will also be found very useful, provided the observer does not live too far away from the latitude for which the Planispehre is especially adapted, namely, 40°–50°.

Next in importance to the star-maps among the astronomer's working books is an Ephemeris. Many of the popular almanacs contain much useful astronomical matter; but I strongly recommend the student to procure the Nautical Almanac of his own country. This gives information that is invaluable to the astronomer: the position of the sun, moon, and planets for every day of the year, the eclipses and occultations for the year, the positions of Jupiter's satellites for every day, etc.; in short, all the phenomena which can profitably occupy the attention of the telescopist.

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* See Mr. Serviss's pleasant little book, *Astronomy with an Opera-glass*.

CHAPTER VII.

OBSERVATION.—STARS, NEBULÆ, THE SUN AND MOON.

The tyro must remember that successful observation with the telescope requires practice and a certain training of the eye. It is not at all unlikely that he may experience some disappointment at the outset of his work by failing to see objects which he has been taught will be visible with such an aperture and such powers; and also by the difference between what he may expect to see and what he actually does see. Let him not be disheartened, nor let him hastily condemn his telescope; but rather let him persevere, practising on the easier doubles and the more conspicuous nebulæ; and he will find that in a comparatively short time he will be able to detect objects of a minuteness and faintness which would have rendered them quite invisible to him at first. On this subject I again refer the reader to Sir Howard Grubb's remarks in Chapter II.

The eye should be steadily fixed on the object under observation; and it will be noticed that details will frequently come out at intervals which are indistinct or even invisible in the mean time. This may be especially noted of the belts of Jupiter and Saturn when working with a small aperture.

In scrutinizing a difficult object it will sometimes be found helpful for the near-sighted observer to take off his eyeglasses or spectacles, altering the focus of his telescope to meet the change. Occasionally the slight

additional loss of light caused by another glass between the eye and the image may just prevent the sight of an object which will become visible when the glass is removed. I have several times experienced this when observing nebulæ.

A very minute star may often be seen by directing the eye not directly upon it, but to another quarter of the field ; the little star is thus seen out of the corner of the eye, so to speak. This familiar fact proves very useful in the perception of very small *comites*.

I append certain directions which the observer will note with regard to observations upon different celestial objects. It is, of course, not within the purpose of this little work to treat minutely of these objects, but only to give such points as may be necessary to the amateur telescopist who proposes to study them with humble instrumental means.

THE FIXED STARS.—In the lists given in this book I have followed Admiral Smyth in his estimate of the colors of stars ; but I must warn the student that these statements concerning color are often rather fantastic, especially with small apertures, which give much less idea of color in a star than do larger ones. When the judgments of observers have differed greatly on this subject, I have stated the opinion of the dissenters from Admiral Smyth.

The powers to be employed upon double stars will be best learned by experiment. They differ in proportion to the distance and brilliancy of the components. Some may be readily seen with the lowest powers, while others will demand the highest powers that a small telescope will bear. Here, as with other objects, the best power to use is the lowest that will effectually do the work. By a

number of experiments Mr. Dawes ascertained that the closest double star which a 1-inch glass could separate was one in which the distance between the components was 4.56″; and he devised the following empirical formula for ascertaining the separating power of different apertures:

$$\text{Separating power in seconds of arc} = \frac{4.56}{\text{aperture in ins.}}$$

The separating power of different apertures would then be as follows:

Aperture.	Least Separable Distance.	Aperture.	Least Separable Distance.
	″		″
1	4.56	4	1.14
1.6	2.85	4.5	1.01
2.0	2.28	5.5	0.91
2.5	1.82	5.5	0.83
3.0	1.52	6.0	0.76
3.5	1.30	6.5	0.70

Mr. Chambers recommends a power of 120 on a 3-inch glass for doubles of a distance from 3″ to 12″; of 240 for any closer ones; and of less than 120 for any doubles of greater distance than 12″.

NEBULÆ.—These weird and most fascinating objects must be reluctantly admitted to be, for their full appreciation, rather beyond the powers of a small telescope. A large light-collecting power—in other words, a large aperture—is needed for their satisfactory study. But the mere *sight* of a nebula has a mysterious and awe-inspiring charm about it; and all the nebulæ listed in this book are at least visible with an aperture of three inches at most. Moreover, there is a singular circumstance in this connec-

tion, mentioned by d'Arrest; which is that a nebula is sometimes seen with a small aperture which is invisible with a large one. M. d'Arrest states that Tempel's nebula in the Pleiades is perceptible in the finder of the 11-inch refractor at Copenhagen, but invisible in the telescope itself.*

Low powers must almost invariably be used upon nebulæ; every enlargement of these objects diminishes the quantity of light available for seeing them.

THE SUN.—It seems unlikely that any one of ordinary sense should need to be warned not to look at the sun through a telescope without the employment of some means to protect the eye against the blazing light of that tremendous orb. And yet no less great an astronomer than Sir William Herschel lost an eye by making that mad attempt. So let the student be earnestly admonished to take the best precautions to shield his eyes when engaged in solar observation. The plan commonly adopted is to use the sun-shades which are usually furnished with eye pieces, the colors of which are either neutral-tint, blue, or red. But with an aperture of more than two inches there is danger that if observation be prolonged the shading glass will crack and the light of the sun be transmitted with perhaps disastrous effect. Red shades are less liable to this calamity than the blue or neutral ones, but even they are not altogether free from danger, and, moreover, a red glass is not a pleasant medium through which to view the sun. The observer may stop his object glass down to two inches or under, or he may turn the instrument away from the sun at short intervals to allow the eye piece and the air within

* Webb, *Celestial Objects*, p. 399.

the tube to cool off; or if he possesses a terrestrial eyepiece, he may use it for solar observations. The additional lenses which this eyepiece interposes between the object glass and the eye absorb some of the light and heat, and much lessen the danger to the shade glass. This is the method recommended by Mr. Proctor, and to the advantages of which I can bear testimony. But if the observer proposes to devote much time to the sun, he will find that one of the forms of the diagonal solar eyepiece will repay him for the expense incurred in its purchase. One of these instruments consists essentially of a perfectly plane piece of plate-glass set at an angle of forty-five degrees with the optical axis of the telescope, so as to reflect the sun's rays at a right angle with that axis. The under side of this reflector is ground, in order to avoid a double reflection, and a very large proportion of the sun's light and heat passes through it. That portion which is reflected is viewed through an eyepiece with a lighter shade, set at right angles with the optical axis.*

In another and more commonly used solar diagonal eyepiece, a front-surface-reflecting prism or wedge is substituted for the plane reflector. This reflects only about one-thirtieth of the sun's light, and scarcely any of its heat.

These devices enable the observer to keep his telescope directed to the sun for an indefinite period.

Perhaps the best of all methods for studying the sun is simply to throw its image upon a sheet of clean white paper or cardboard. The ingenious amateur will easily contrive a method of supporting this cardboard. One favorite plan is to make a light cone or pyramid with its small end attached to the eye-end of the telescope, the

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* Noble, *Three-inch Telescope*, p. 9.

framework being made of stiff wire or, better, bamboo, and covered with black calico or cambric. The bottom of this pyramidal box holds the cardboard sheet on which the image is received. An opening in the side of the pyramid enables the observer to see the image. A photographer's focusing cloth placed over the observer's head will keep off extraneous light and enable him to study with ease and pleasure the phenomena of the solar surface.

The most prominent of these phenomena are, of course, the spots. These are never, according to Mr. Howlett, less than three seconds in length or breadth, and are consequently fully within the grasp of a small telescope. Each spot which can be sufficiently magnified for such a purpose will be seen to consist of a central black portion, or *umbra*, surrounded by a region less dark, called the *penumbra*. These spots are depressions or openings in the sun's photosphere, or outward envelope. *Faculæ* are supposed to be elevations or ridges on the photosphere. They are streaks and spots of light, usually in the neighborhood of dark spots, and are sometimes of very singular form.

To catch the mottling or graining of the solar surface, Captain Noble recommends the shifting about of the telescope so as to cause the sun's image to move about in the field, when "the eye will soon receive the impression of a roughness or grain upon the sun's surface, akin to that of a piece of magnified loaf sugar."

THE MOON.—With a sense of relief we turn away from the glare of the sunlight, with its revelation of the common things of earth, to the quiet and mystic beauty of the "astronomer's day." Our lovely satellite presents an ever varying and ever interesting subject of study,

and I much regret that the limits of this book forbid as full a description of the moon as I should like to present to the reader.

The moon should be carefully scanned by the observer as she passes through her phases, and it is recommended that he try to make two observations each evening, one as early and the other as late as possible. In this way he will be able to observe the gradual creeping of the sunlight over the craters and mountains of the "spotty globe," and to note the extraordinary effects produced by the gradual advance or retreat of the *terminator* or the irregular line marking the limit to which the illumination reaches. "The outlying and isolated peak of some great mountain chain becomes gradually larger and is finally merged into the general luminous surface; great circular spaces, enclosed with rough and rocky walls many miles in diameter, become apparent; some with flat and perfectly smooth floors variegated with streaks; others in which the flat floor is dotted with numerous pits, or covered with broken fragments of rock. Occasionally a regularly formed and unusually symmetrical circular formation makes its appearance, the exterior surface of the wall bristling with terraces rising gradually from the plain, the interior one much more steep; and instead of a flat floor, the inner space is concave or cup-shaped with a solitary peak rising in the centre. Solitary peaks rise from the level plains and cast their long, narrow shadows athwart the smooth surface. Vast plains of a dusky tint become visible, not perfectly level, but covered with ripples, pits, and projections. Circular wells which have no surrounding wall dip below the plain, and are met with even in the interior of the circular mountains and on the tops of their walls. From some of the mountains great

streams of a brilliant white radiate in all directions and can be traced for hundreds of miles. We see again great fissures almost perfectly straight and of great length, although very narrow, which appear like the cracks in moist clayey soil when dried by the sun." *

The student who desires to go minutely into the study of the topography of the moon should procure Neison's admirable book on this subject. For an amateur's purposes the brief study given here may perhaps suffice. An excellent map of the moon is given in Webb's *Celestial Objects* and may be obtained separately for eighteen pence from Longmans, Green & Co., of London and New York. This map is given in a reduced form in Noble's *Three-inch Telescope*, and from it the guide-map presented in this book is prepared.

In the following brief descriptions of lunar objects I have simply used the words *above*, *below*, *right*, *left*, etc., rather than employ the points of the compass according to the usage of selenographers. It may be well to state, however, that in maps of the moon as seen in an inverting telescope (and such is our guide-map), the North and South points occupy the bottom and top of the map respectively, while the East and West points are at the right and left respectively, as in terrestrial maps.

The map represents the moon at the period of its mean libration, and the expressions *above*, *below*, etc., must be understood as describing the relative positions of objects at that period.

1. TYCHO.—We begin with what Webb calls "the metropolitan crater of the moon." This will be instantly

* From a paper by Breen, in *Popular Science Monthly*, quoted by Proctor, *Half-hours*, p. 93.

recognized as the most conspicuous object on the face of our satellite when full—a crater from which radiates a vast system of rills or rays extending over at least a quarter of the disk. It is visible to a sharp eye without optical aid, has a diameter of 54½ miles, and its walls rise at the highest point to 17,000 feet. Its central hill is between 5,000 and 6,000 feet high. To its left is Pictet, to the left of which is Saussure. To the right of Tycho is Heinsius. Above and a little to the left is Street, above which is Maginus—a noble formation which utterly disappears at full moon.

2. PLATO.—A grand ring-plain 60 miles across. Under it extends the *Mare Frigoris;* above it to the right is the *Mare Imbrium*, and to the left the *Mare Serenitatis.* Plato was called by Hevelius the "Greater Black Lake," and, with the exception of Grimaldi, is the darkest part of the moon's surface.

3. LINNÉ.—A small crater in the *Mare Serenitatis*, where indications of recent volcanic action have been thought to be seen; an opinion favored by Proctor and Webb.

4. ARISTARCHUS.—The most brilliant portion of the moon's surface. "Its peaks shine often like stars when the mountain is within the unillumined portion of the moon's surface." (Proctor.) At times "its lustre is actually unpleasant to the eye, even in a three-inch telescope." (Noble.) Its central mountain seems even brighter than the walls of the crater. Immediately to the right of it lies Herodotus.

5. MESSIER.—Two craters from which extend two singular straight streaks, giving the object an appearance somewhat like a comet, and suggesting its name from the famous French "comet ferret," M. Messier.

6. THE ALPS.—A grand range of mountains strongly resembling terrestrial systems. The chain is interrupted by a vast valley between 80 and 90 miles long, and from 3½ to 6 miles across.

7. THE APENNINES.—A magnificent range resembling that of the Alps, but including higher peaks, and culminating in Mount Huygens, 20,000 feet high. This chain is one of the portions of the moon which frequently project beyond the terminator so strikingly at times that a keen eye may perceive it without a telescope. The range terminates in the splendid crater Eratosthenes. Above and to the left of Mount Huygens lies the *mare* called Middle Bay.

8. FRASCATORIUS.—A curious "bay" at the upper end of the *Mare Nectaris*. Below it and to its right, on the edge of the *mare*, is Beaumont.

9. POSIDONIUS.—One of the largest ring-plains on the moon, 62 miles in diameter, with a fine central crater. It lies in the *Mare Serenitatis*, and has a smaller ring-plain (Chacornac) attached to it toward the left.

10, 11, 12. THEOPHILUS, CYRILLUS, CATHERINE.—A grand triple group. Study it carefully. Note the two mountains in Cyrillus and the crater on its wall. Theophilus is the deepest crater in the moon, its wall rising, in places, 18,000 feet above the bottom. Its diameter is about 64 miles, and when the moon is about five days old, the illuminated portion of the summit of Theophilus is projected beyond the terminator as a luminous ring.

13, 14, 15. ARZACHEL, ALPHONSUS, PTOLEMY.—Another splendid triple group, the components being, respectively, 65½, 83, and 115 miles in diameter. Alphonsus contains a mountain, and Arzachel a mountain and a crater. On the upper right-hand portion of the wall of Alphonsus

will be seen the fine crater Alpetragius, and at the lower part of Ptolemy is the equally fine Herschel. Above and to the right of Arzachel is an enormous straight cliff known as "Straight Wall" or Range, and sometimes called The Railway.

16. PICO.—An isolated peak in the *Mare Imbrium*, 8,000 feet high, and casting an extraordinarily long shadow under oblique illumination. It is directly above Plato. To its right and at about the same distance from Plato is the curious little group called the Teneriffe Mountains.

17. COPERNICUS.—A magnificent ring-plain, one of the finest, if not the finest, in the moon. It is 56 miles across, and is one of the centres from which radiate the curious light-rays or rills. Below it is a pretty pair of craters, the larger of which is known as Gay-Lussac, and, more than twice as far away, lower and more to the right, is Tobias Mayer, with a more recently erupted crater on its left side. Between Gay-Lussac and Tobias Mayer is Mount Carpathus.

18. MOUNT HUYGENS.—See Apennines.

19. EUCLID.—A small crater surrounded by a sort of nimbus. It is in an island, so to speak, in the *Oceanus Procellarum*.

20. VITELLO.—A most curious formation at the upper end of the *Mare Humorum*. It consists of a ring enclosing another one, from the centre of which rises a hill nearly 1,700 feet high. It is connected by a curving ridge with the crater called Doppelmayer.

21. THE DÖRFEL MOUNTAINS.—An enormous range, almost on the limb of the moon, and sometimes strikingly seen in profile. The three chief peaks probably exceed 26,000 feet in height. Just below them is the enormous ring-plain Bailly.

22. WARGENTIN.—A most singular object resembling an extremely truncated column 54 miles across. Webb compares it to a large thin cheese. It appears to be a crater filled to the brim with lava. Just below it is the grand ring-plain Schickard, about 153 miles in diameter.

23. AIRY.—See 28.

24. ERATOSTHENES.—A splendid crater with three central peaks. It is 37½ miles across, and terminates the chain of the Apennines.

25. PICCOLOMINI.—A fine ring-plain 57½ miles across. Its wall is somewhat complex and has on its right edge a tower about 15,000 feet high. The Altai Mountains start from Piccolomini and terminate in Tacitus. Their principal summits rise to about 13,000 feet. Along their right side are the craters Pons and Fermat, and on their left is Polybius, just above Catherine. The group of huge craters to the right of Fermat is Sacrobosco.

26. GRIMALDI.—An immense dark plain about 148 miles long by 129 wide. It is probably the darkest part of the moon. Immediately below it is the triple group Lohrmann, Hevel, and Cavalerius; to its right, and below, is Riccioli; to its left, Damoiseau, and above it, Rocca.

27. ARCHIMEDES.—A fine but comparatively shallow ring-plain 50 miles across. A fine object in the rising or setting sun. On a level with its lowest part and to the left is Autolycus, below which is Aristillus. These two craters are surrounded by remarkable radiating banks like lava streams.

28, 29, 30, 31. WALTER, REGIOMONTANUS, PURBACH, LACAILLE.—Four ring-plains at the upper end of a curious chain of craters, of which the last but one is Airy.

32, 33, 34. PARRY, BONPLAND, FRA MAURO.—A fine triple group.

35. MARE CRISIUM.—An immense plain, one of the most conspicuous objects on the moon. From the upper border a huge cape (Promontorium Agarum) projects about 50 miles into the *mare*. Just to the right of the *mare* is the brilliant little crater Proclus.

36. SINUS IRIDIUM (Bay of Rainbows).—A beautiful formation at the lower part of the *Mare Imbrium*. Beer and Mädler pronounce this "perhaps the most magnificent of all lunar landscapes." The capes at the right and left are respectively capes Heraclides and Laplace.

37. CLAVIUS.—A splendid crater, peculiarly impressive in sunrise. It is more than 142 miles broad, and is "encompassed by a wall damaged by successive explosions, but still portentously high and steep, attaining 17,300 feet in one of its western peaks, and covering the gulf with night amid surrounding day." (Webb.)

38. GASSENDI.—A noble crater 54 miles across, with a group of conical mountains in the centre. It has two small craters attached to its lower end.

For the more minute study of the above lunar objects pretty high powers are advisable. The illumination being ample, the highest powers of the telescope may be profitably employed, if the atmospheric conditions are favorable and the stand steady. But the most pleasing views of the moon are those obtained with lower powers, and it is surprising how much detail may be observed with such powers, if the objective is a good one. I have often seen the streaks extending from Messier, and the Valley of the Alps, with a power of 48 on a 2½-inch glass.

One of the most interesting phenomena in connection with the moon is the *occultation* by it of some star or planet; in other words, the passage of our satellite be-

tween a celestial object and some point on the earth's surface. These occultations are extremely valuable, as a little reflection will show, in the determination of terrestrial longitudes, and are therefore predicted with great care and accuracy in the Nautical Almanac. When a fixed star is occulted by the moon's dark limb, the suddenness of its disappearance is simply startling. One instant the star is shining in full brilliancy, the next it is as if blotted out of existence.

The occultation of a planet is a not unfrequent occurrence, and is a spectacle of great beauty and interest, although lacking the "dramatic suddenness" characteristic of the occultation of a fixed star.

A singular phenomenon is sometimes witnessed when a star is occulted by the bright limb of the moon. This is the apparent projection of the star on the edge of the moon itself. This strange appearance has heretofore only been noted in the case of red or reddish stars, and is as yet unexplained. It should be watched for, although it is not very likely to be noted in a small telescope.

CHAPTER VIII.

OBSERVATION, CONTINUED.—THE PLANETS.

MERCURY.—It is a matter of some little difficulty to the observer whose telescope is without graduated circles, to get a sight of this elusive little planet. A few days before and after its greatest eastern elongation from the sun is the best time to see it. At its western elongation it is, of course, equally easy to see, provided the observer is willing to get up a sufficient time before sunrise, which few amateurs are sufficiently enthusiastic to do. But what with low-hanging clouds and atmospheric vapors, the opportunities of seeing Mercury are rather rare; and moreover, owing to his nearness to the sun at the best of times, he will not easily be detected during his visibility, unless his place is known.

Mr. Proctor * gives an ingenious plan for finding this planet. It consists essentially of calculating the time when Mercury will appear at a given point, by taking the difference between the right ascension of the sun and that of the planet, and then noting the time at which the sun crosses the given point. At a time after that, equal to the difference of right ascensions, Mercury will cross that point, allowance being made for the difference of declinations. But by roughly estimating the position of Mercury, and carefully "sweeping" about that point with an opera or field glass, the planet can usually be picked up without the employment of any troublesome devices.

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* *Half-hours*, p. 77.

The apparent diameter of Mercury at its inferior conjunction is 12.9″, and at its greatest elongation only 7″. To examine the planet with any satisfaction a high power is required—not less than 100 at the lowest.

VENUS.—This splendid planet is one of the finest of celestial objects, but at the same time one of the most trying to the telescope. Its intense brilliancy brings out every defect of the instrument, and sometimes the observer is compelled to stop down his object-glass to obtain a view of this planet free from "wings." Powers of from 80 to 200 may be employed. The apparent diameter of Venus varies between 9.7″ in superior and 66.5″ in inferior conjunction.

An hour at which the sun is still above the horizon is the best time for observing Venus, as the illuminated sky subdues the glare of the planet. By far the most striking view which Venus ever presents in the telescope is that obtained when she is in, or very near, her inferior conjunction. She is then at her greatest apparent diameter; but all that the observer can see is a brilliant and beautiful sickle of white light. Captain Noble recommends that for this observation the diaphragm between the lenses of the eyepiece be replaced by another of blackened cardboard, through the centre of which has been pierced a fine hole with a red-hot needle.

MARS.—For the satisfactory study of this most interesting planet an object-glass of at least four inches is required; nevertheless, under favorable circumstances, striking and beautiful views of Mars may be obtained with quite small apertures. The only time, however, when such telescopes will give such views is when the planet is in or near opposition; especially when the opposition takes place under the peculiarly favorable circumstances

presented, on the average, every fifteen years, when the earth is furthest from the sun and Mars nearest to it. Under such circumstances the apparent diameter of the fiery planet is 30.4″, which decreases to 4.1″ at conjunction. The outlines of continents and seas may be detected when Mars is at his greatest apparent diameter, with a 2½-inch glass with a power of from 150 to 200, and the polar snow-caps may be seen with a power of 100 or even less. Even a 2-inch glass may do fairly good work under favorable circumstances. High powers are necessary to the study of this planet, and magnifying may be pushed to the full extent of the telescope's capacity.

The phases of Mars may be seen with any power which will exhibit a fairly good-sized disk. At quadrature it is decidedly gibbous, resembling the moon at about three days from full.

It is unnecessary—almost absurdly so—to state that the satellites of Mars are utterly beyond the reach of a small telescope.

THE MINOR PLANETS.—A large number of these interesting little bodies could be seen with a small telescope, provided their places were known. Tables of the elements of most of them may be found in *Kirkwood's Asteroids* and in *Loomis's Practical Astronomy.* To calculate the present position of any one of them, its longitude at a given epoch is required. This is given in the case of each planet by Loomis. But the sight of few of these "pocket planets" will repay the amateur for the laborious computations necessary to find them; so that the asteroids may be regarded, for all practical purposes, as outside of our student's line of work.

Ceres, at the most favorable period, shines as a seventh-magnitude star and at other times as an eighth. Its light

is reddish. Juno is very similar to it in size and color. Pallas, the largest of all, appears, when in opposition, as a star of the seventh magnitude, with a yellowish tinge. Vesta is at times as bright as a white sixth-magnitude star.

JUPITER.—This gigantic orb is one of the standard objects of study and admiration for the amateur telescopist. Its changing belts, its circling satellites, and the splendor of the entire system render Jupiter a source of unfailing pleasure and wonder.

The apparent diameter of this planet varies from 50.7", in opposition, to 30 8", in conjunction. Very little optical aid, therefore, is required to exhibit its disk. A power of fifty for every inch of aperture will exhibit the belts excellently and the flattening of the planet at the poles. Lower powers, however, must be used to see the entire Jovian system at a glance, say a power of from forty to fifty in a two-inch telescope, and even lower powers in a larger one.

The student will be at once struck with the singular and beautiful belts which stretch across the planet's disk. In large telescopes these belts exhibit striking differences of color ; but in small ones they are usually of a uniform dusky hue. They change in number and breadth from time to time, sometimes exhibiting curious and beautiful scalloped forms. One night's observations will reveal, with sufficient powers, a difference in their general aspect, owing to the swiftness with which this monster globe revolves on its axis.

The most interesting phenomena in the Jovian system are, of course, those connected with the satellites. These bodies are distinguished by Roman numerals, in the order of their distance from the primary. I., II., and IV

appear as stars of the seventh magnitude ; III. as one of the sixth magnitude. Each night's observation will show them in a different position with reference to their primary ; and it is interesting to compare their observed positions with the predicted ones as laid down for each day in the Nautical Almanac. The tiny fifth satellite is, of course, invisible in a small telescope.

The phenomena connected with the satellites are occultations, eclipses, and transits. An occultation is the passage of a satellite behind the planet ; a transit is the passage of a satellite across the face of the planet : and an eclipse is the entrance of a satellite into the shadow of its primary.

Eclipses may be observed with small instruments and low powers. Transits are much more difficult with such means. The shadows of the satellites on Jupiter's disk may be seen, under favorable circumstances, with a two-inch glass, but to see the satellites themselves projected on the disk requires a larger aperture—not less than three inches. The satellites appear on the disk as luminous points, preceded or followed by their shadows, which exhibit themselves as round *dark* spots, not *black*, as the visible shadows are largely composed of penumbra. The shadow of IV. is nearly all penumbra, and even that of I. is not wholly black.* The shadow of IV. is nearly double the diameter of the satellite itself, and is larger than that of III., although IV. is smaller than III.† The shadow precedes the satellite when Jupiter is passing from conjunction to opposition, but follows it when the planet is between opposition and conjunction.

The occultations are the most difficult of the Jovian

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* Proctor, *Half-hours*, pp. 86, 87. † Lassell.

phenomena to small apertures; but it may be added that they are also the least interesting. All these phenomena are duly predicted in the Nautical Almanac.

SATURN.—Beyond all comparison this wonderful planet is the most beautiful and striking object in the solar system. Its retinue of satellites and its stupendous rings make it by far the most gorgeously attended of all the planets. Its satisfactory study is just beyond the powers of a small telescope, an aperture of four inches being required for a reasonably complete view. Enough may be seen with a small instrument, however, to make Saturn a source of unfailing wonder and admiration. The apparent diameter of this planet varies from 14.6″, in conjunction, to 20.3″, in opposition.

The belts of Saturn are much less conspicuous than those of Jupiter, but a three-inch telescope, or even, at times, a two-inch, will show them. The satellites will prove very difficult objects to our observer, with the exception of Titan and, under some circumstances, Japetus. A two-inch glass will show these, if Japetus is near its western elongation; a three-inch may show Rhea also; a four-inch will add Tethys and Dione. The others require large and powerful instruments. Eclipses, etc., in the Saturnian system need not here be dwelt upon, as they will be utterly beyond our observer's telescope.

The ring may be seen readily with a two-inch telescope. According to Mr. Proctor,* this aperture will also show Ball's (Cassini's) division in the ring, but I have never been able to detect this feature with anything under three inches. Nothing below four inches will

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* *Half-hours*, p. 92.

show the curious and beautiful inner dusky or "crape" ring.

The rings are known as A, B, and C, counting from the outer ring. Ball's division forms the boundary between A and B, but A is also marked by Encke's division, which is much beyond the powers of a small telescope.

A three-inch glass should show the difference between the colors of rings A and B, the latter being decidedly more silvery than the former and presenting a lovely contrast with the yellow ball of the planet.

High powers may be used upon Saturn with more satisfaction than upon Jupiter, and the observer is advised to try upon this glorious orb the highest powers that his telescope will bear. He will find it worth his while to watch and wait for atmospheric conditions sufficiently favorable for this purpose.

Uranus and Neptune.—Our amateur will be able to see these planets as stars, and even, with sufficient power, to raise them to disks. To find them with an altazimuth, their right ascension and declination must be taken from the Nautical Almanac, and their places carefully marked on a map or planisphere. They may then be aligned from neighboring stars. The apparent diameter of Uranus never reaches four seconds, and a power of at least two hundred is required to show it as a disk. Neptune will hardly be distinguished from a dull eighth-magnitude star except by the greater steadiness of its light and the absence of diffraction rings around it. "What is the lowest power," says Mr. Proctor, "which will exhibit Neptune as a disk, I do not know; but I am certain no observer can mistake him for a fixed star with a two-inch aperture and a few minutes' patient scrutiny in

favorable weather."* "The observer with a three-inch telescope," says Captain Noble, "may be contented if he can fairly satisfy himself that it is not a star that he is looking at."†

* *Half-hours*, p. 92. † *Three-inch Telescope*, p. 80.

CHAPTER IX.

PRICES OF TELESCOPES AND THEIR ACCESSORIES.

FOR the convenience of intending purchasers of telescopes, I deem it essential to the completeness of this little handbook to give the names of certain well-known and reliable opticians and manufacturers, together with the prices asked by them for their instruments. I subjoin extracts from the price-lists of three American and two English artists and dealers, by the aid of which the amateur may lay out the sum set apart for his astronomical recreations to the best advantage. The firms referred to are the following:

ALVAN CLARK & SONS, CAMBRIDGEPORT, MASS.—These world-renowned artists are the makers of the great Lick telescope of thirty-six inches aperture; of the Pulkowa, thirty-inch; the Washington, twenty-six-inch; the University of Virginia, twenty-six-inch; and other famous and magnificent instruments. They make for the use particularly of amateurs a series of comparatively small and simply mounted refractors of low price and, of course, distinguished excellence.

GEO. N. SAEGMULLER, late FAUTH & CO., WASHINGTON, D. C.—This eminent firm are the makers of the twelve-inch equatorials of the Ladd Observatory, Providence, R. I., the Georgetown College Observatory, and the new Naval Observatory at Washington; and of the nine-inch equatorial of the Catholic University in the same city.

QUEEN & CO., PHILADELPHIA.—This firm manufactures and imports a cheaper but well-recommended class of instruments.

J. COOKE & SONS, YORK, ENGLAND.—These celebrated artists are the makers of the noble twenty-five-inch Newall refractor now at Cambridge, and other grand telescopes. They rank among the great opticians of the world.

HORNE, THORNTHWAITE & WOOD, 416 STRAND AND 74 CHEAPSIDE, LONDON.—An old and well-known firm, making a cheaper class of telescopes.

ACHROMATIC OBJECT-GLASSES, MOUNTED IN CELLS.

CLARK—

3-inch.	3½-inch.	4-inch.	4½-inch.	5-inch.	6-inch.
$50.00	$75.00	$100.00	$140.00	$200.00	$350.00

SAEGMULLER—

2-inch.	3-inch.	3½-inch.	4-inch.	4½ inch.	5-inch.
$30.00	$60.00	$80.00	$100.00	$140.00	$180.00
		5½-inch.	6-inch.		
		$250.00	$360.00		

QUEEN—

2½-inch.	2¾-inch.	3-inch.	3⅝-inch.	4-inch.	4½-inch.
$15.00	$25.00	$30.00	$55.00	$80.00	$125.00
		5-inch.	5½-inch.		
		$265.00	$350.00		

COOKE—

2-inch.	2¼-inch.	2½-inch.	2¾-inch.	3-inch.	3½-inch.
£2 2s.	£3 5s.	£4 15s.	£7	£9 10s.	£14
	4-inch.	4½-inch.	5-inch.	6-inch.	
	£20	£26	£34	£48	

HORNE, THORNTHWAITE & WOOD—

2½-inch.	3-inch.	3½-inch.	4½-inch.	5-inch.
£2 15s.	£5	£8	£18	£26

TELESCOPES, UNMOUNTED.

CLARK.—Each telescope is provided with a finder, diagonal eye-tube, front-surface reflecting solar prism, one terrestrial eye-piece, and four celestial eye-pieces.

4-inch.	4½-inch.	5-inch.	6-inch.
$220.00	$270.00	$360.00	$550.00

The same without any accessories except four celestial eye-pieces :

4-inch.	4½-inch.	5-inch.	6-inch.
$160.00	$210.00	$300.00	$490.00

SAEGMULLER.—Telescopes of 3 inches and upward have finders. The figures in parentheses refer to the number of eye-pieces furnished with each instrument.

2½-inch (2).	3-inch (3).	3½-inch (3).	4-inch (4).	4½-inch (4).	5-inch (5).
$90.00	$145.00	$165.00	$210.00	$265.00	$325.00

QUEEN.—These instruments have blackened steel bodies with brass mountings. Sizes below 4 inches are without finders. The 3-inch telescope is provided with three eye-pieces, all others with four.

3-inch.	3½-inch.	4-inch.	4½-inch.	5-inch.	6-inch.
$125.00	$175.00	$225.00	$300.00	$450.00	$600.00

COOKE.—These telescopes have brass tubes, and all over 2½ inches aperture are provided with finders, dew-caps, and solar eye-pieces. Each has one terrestrial eye-

piece. The figures in parentheses refer to the number of astronomical eye-pieces furnished with each instrument.

2¼-in. (1).	2½-in. (2).	2¾-in. (2).	3-in. (3).	3½-in. (4).	4-in. (4).
£10 15*s.*	£14	£18 10*s.*	£23	£30	£40

4½-in. (4).	5-in. (5).
£54	£67

Portable Equatorial Stands.

Clark.—Plain equatorial of best construction, without circles, with tangent wheel for slow motion in right ascension, $110.

Saegmuller.—Equatorial stand with tangent movements, silvered circles reading respectively to 5 seconds of R. A. and single minutes of declination, $150.

Queen.—Small equatorial head, without stand, $18. Universal Equatorial (*i.e.*, one adaptable for any latitude), of fine quality, without circles, fitted with tangent movement, brass-mounted, $75 ; clamp for telescope, $6 extra ; universal handle for R. A. wheel, $5 extra. A larger and finer stand, with graduated adjustment for latitude ; 7-inch circles divided on solid silver, reading to 4 seconds in R. A. and 1′ in declination ; circles read by verniers and microscopes ; $250.

Cooke.—Fine and heavy equatorial tripod-stand, universal adjustment, circles graduated on silver, with verniers and reading microscopes ; tangent screw motions in R. A. and declination brought down to eye-end, and cross-levels. Made in three sizes.

Complete, for telescopes	5 to 5½ inches . . .	£66
" " "	4 to 4½ "	50
" " "	3 to 3¾ "	41

With gun-metal circles instead of silver, the prices of the above stands are £62 10*s*., £47, and £38 10*s*., respectively; and if the tangent-motion is not to be brought down to the eye-end (a luxury which may be dispensed with) deduct £8, £7, and £6 10*s*. from the foregoing prices.

H., T. & W.—Universal equatorial for telescopes up to three and a half feet long, 6-inch brass circles reading respectively to 10s. in R. A. and 3′ in Dec., £15 15*s*. Same, without stand, for a 3½-inch telescope, with silver circles and tangent movement, £50; for 4½-inch telescope, £60.

TELESCOPES COMPLETE.

CLARK.—Mounted on superior equatorial stand, without circles, finished in first-class style, each telescope provided with a finder, diagonal eye-tube, front-surface reflecting solar prism, one terrestrial and four celestial eye-pieces.

4-inch.	4½-inch.	5-inch.	6-inch.
$325.00	$380.00	$450.00	$650.00

SAEGMULLER.—May be ascertained from foregoing estimates.

QUEEN.—May be ascertained from foregoing estimates.

COOKE.—If equatorially mounted, the prices may be estimated from data already given; but if mounted on altazimuth stand, the prices are as follows:

2¼-inch, £16 16*s*.; 2½-inch, £20; 2¾-inch, £28, or with tangent screws, £32; 3-inch, £32, with t. s., £36; 3¼-inch, £39, with t. s., £43 10*s*.; 3½-inch, £42 10*s*., with t. s., £47; 3¾-inch, £50 10*s*., with t. s., £55 10*s*.;

4-inch, £55 10*s.*, with t. s., £60 10*s.* ; 4¼-inch, £62 10*s.*, with t. s., £67 10*s.* ; 4½-inch, £69, with t. s., £76 10*s.* ; 5-inch, £84, with t. s., £94.

H., T. & W.—These telescopes have brass bodies. Each is provided with a finder and one terrestrial eye-piece and is mounted on a brass pillar-and-claw stand. The figures in parentheses refer to the number of celestial eye-pieces furnished with each instrument.

3-in. (1).	3¼-in. (2).	3½-in. (3).	3¾-in. (4).	4 in. (5).	4½-in. (5).
£14 14*s.*	£18 18*s.*	£35	£45	£55	£70

Mounted on equatorial stands with diagonal eye-tube, solar eye-piece, circles, levels, etc.

3½-inch.	4-inch.	4½-inch.	5-inch.
£65	£80	£95	£125

With the last two instruments an iron pillar is furnished, if desired, in lieu of the tripod, without extra charge.

Eye-pieces (Huygenian).

Saegmuller.—From ¼-inch to 1-inch, $5.50.

Queen.—From ⅛-inch to 1-inch, $5.50. Munich 3-lens eye-pieces, giving extra large field, 1-inch, $6.00 ; ¾-inch to ⅛-inch, $4.50. Adapter to fit draw-tube, $1.50.

Cooke.—19*s.* each.

H., T. & W.—From 15*s.* to £1 5*s.*

Accessories.

First-surface reflecting prism for solar observations: Saegmuller, $15 ; Cooke, £1 5*s.*; H., T. & W., £1 12*s.*

CHEAPER TELESCOPES.

The cheapest of the above-described instruments will doubtless be beyond the means of many a student to whom the possession of a telescope is an object of earnest desire. But they are all instruments of a high class, some of them, indeed, of the most perfect quality that art can produce. While such telescopes are of the kind which the amateur should strive to secure, there are others to be had of very fair quality and much lower price. A three-inch telescope of French manufacture, fitted with a terrestrial eye-piece magnifying fifty times, and a celestial one magnifying one hundred times, is commonly sold, unmounted, by city opticians for $60, and will do very fair service if provided with one or two additional eye-pieces. A better instrument of the same aperture, made by Bardou, of Paris, and mounted on a pillar-and-claw stand, is sold for $120.

But should even the cheaper of these instruments be beyond the means of the student, let him not despair. A good second-hand "spy-glass" may often be purchased for a small sum; and if its aperture equal two inches, as that of many ship-telescopes does, it may be mounted after one of the methods described in Chapter II. and provided with either astronomical eye-pieces, or, what serves just as well for small apertures, with microscopic eye-pieces. These are of the Huygenian form, and cost less than the others. Such eye-pieces, of the best quality, may be obtained from the Bausch and Lomb Optical Co., of Rochester, N. Y., for $3 each.

Such a telescope was used by the author for many years; and if the objective is at all good, quite a large

proportion of the objects described in this book will be found to be within the range of its powers.

The catalogues and circulars of the following artists and manufacturers may also be consulted with profit:

John Byrne, with Gall & Lembke, 21 Union Square, New York; a maker of objectives, etc., of the highest class.

J. A. Brashear, Allegheny, Pa. Highest-grade objectives, etc.

Warner & Swasey, Cleveland, Ohio. Equatorial mountings of the finest character.

W. & D. Mogey, Bayonne, N. J. Small equatorial mountings.

The Greek Alphabet.

α Alpha.	ι Iota.	ρ Rho.
β Beta.	κ Kappa.	σ Sigma.
γ Gamma.	λ Lambda.	τ Tau.
δ Delta.	μ Mu.	υ Upsilon.
ε Epsilon.	ν Nu.	φ Phi.
ζ Zeta.	ξ Xi.	χ Chi.
η Eta.	ο Omicron.	ψ Psi.
θ Theta.	π Pi.	ω Omega.

Celestial Objects.

In the following catalogue the positions of objects are given for the year 1890, except in a few cases where the positions are for 1880, and are stated to be so. I have not considered it necessary to bring these latter positions up to date, as they are sufficiently accurate for finding purposes.

Position angles are omitted, as they serve no purpose for the amateur telescopist.

All quotations not otherwise credited are from Admiral Smyth's *Cycle of Celestial Objects*, which is the principal source from which these lists have been compiled.

Greek letters not followed by the name of a constellation refer to stars in the constellation then under description.

The following abbreviations are employed in this catalogue :

R. A., Right Ascension.

Dec., Declination ; +, North ; —, South.

D., Distance.

𝔚, Sir William Herschel. The Roman numerals following this sign refer to the number of that catalogue of nebulæ containing the object under description.

H., Sir John Herschel's General Catalogue of Nebulæ, 1864.

M., Messier's Catalogue of 103 Nebulæ, 1783–84.

P., Piazzi's Palermo Catalogue, 1814. The Roman

numerals following this initial refer to that one of the XXIV. hours of R. A. into which this catalogue is divided, which contains the object under description.

h., Sir John Herschel's First Catalogue of Nebulæ, 1833.

h.*, Sir John Herschel's General Catalogue (so-called) of Double Stars.

B., Bode's Catalogue.

Lal., Lalande's Catalogue.

Σ, Wilhelm Struve's great Dorpat Catalogue of Double Stars.

B. A. C., British Association's Catalogue.

Birm., Birmingham's Catalogue of Red Stars, 1877.

Dunlop. His Catalogue of Southern Clusters and Nebulæ.

A telescopic field is divided into four imaginary quadrants, which are designated respectively *south preceding*, *south following*, *north preceding*, and *north following*; usually expressed by the initials *sp*, *sf*, etc. They are placed as in the diagram.

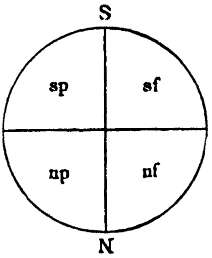

FIG. 12.

The number of stars in each constellation is given according to Bode's estimate.

ALIGNMENT STARS.

The position, with reference to conspicuous stars, of many of the objects used in the following pages for the "alignment," to use Admiral Smyth's convenient word, of inconspicuous celestial bodies, is already given in the Catalogue itself; but I append directions for quickly and

easily finding all the stars used for alignment in these lists in order to save the student from having to distract his attention and unfit his eyes for immediate use at the telescope by poring over a map by lantern light.

While it is by no means necessary, the observer will greatly facilitate his work, increase his knowledge of the heavens, and keep his eyes in good condition for the telescope by memorizing the positions of all these guiding stars—a task which will be found far less formidable than it sounds.

A knowledge of all first-magnitude stars, of Polaris, and of the general positions of the constellations is assumed.

ANDROMEDA.—Draw a line from Polaris through the brighter of the two stars forming the seat of Cassiopeia's Chair, and extend it 25°. It will reach a point 3° W. of a second-mag. star, which is β. S.W. of β, and $7\frac{1}{2}°$ from it, is a third-mag., which is δ, and the same distance from δ, W. and a little S., is a second-mag., which is α. $3\frac{1}{2}°$ N.W. of β, and forming with it a curved line, are two fourth-mag. stars, the lower of which is μ, the other ν.

AQUARIUS.—Draw a line due N. from Fomalhaut 14°. It will pass very near δ, of mag. three, the brightest star in that neighborhood. Draw a line from Fomalhaut through δ, and 16° on. $3\frac{1}{2}$ W. of the point thus reached are three stars forming a nearly straight line 7° long, due E. and W. They are, in that order, η (4), ζ (3), and α (3). Just S. of the middle of the line is γ (3). 10° S.W. of α is β (3). A line from Fomalhaut to δ, and $8\frac{1}{2}°$ on, reaches λ (4), and 6° E., about 2° S., is a little group of three stars, of which the fourth-mag. one is ψ. 8° exactly S.W. of β is ν (4).

AQUILA.—α is almost midway between γ (3) and β (4), the three stars forming a line nearly 5° long with β at the

S. end. This line points to θ (3), 8½° S. Just east of the line between α and β, 1° from α, is ξ (5). 4½° W. of α, nearly at right angles with the above line, is μ (5). A line from ξ to β and 4½° on passes about 1° E. of η. Draw a line from Polaris through Lyra, and at a point 12½° N.W. of Altair it will strike a third-mag. star, which is ζ (3). 18½° due S. of ζ is λ (3). 2° N.W. of ζ is ϵ (4).

ARIES.—This constellation contains but two stars of mag. three. α is 24° due W. of the Pleiades, and β 4° S.W. of α. γ (4) is 1½° S. of β. ϵ (4) is 12½° from α, on line to Aldebaran.

AURIGA.—β (2) is 7½° E. of α. 9° due N. of β is δ (4). 5½° S. and somewhat W. from α, are two fourth-mag. stars about 1° apart. The one to the E. is η, the other ζ.

BOÖTES.—The first bright star N.E. of α is ϵ, 10° distant, and 8½° further on in the same line is δ (3). β (3) is 8° N., a little W. from δ.

CANCER.—Draw a line from Regulus to Procyon. It will pass, at a distance of 17½° from the former—something less than half way—3° S. of a fourth-mag. star, which is α. 6½° N. and 3½° W. of α is a fourth-mag., which is δ. 11° due N. of δ is ι (4).

CANES VENATICI.—A line from Polaris through the northernmost of the three stars forming the handle of the "Dipper," and 17½° on, will reach α, a bright third-mag. star.

CANIS MAJOR.—The conspicuous third mag. 5⅘° W. and somewhat S. of Sirius is β. S. and W. of α are four third-mag. stars forming, as it were, three arms of a cross. The central one is δ, the furthest W. is ϵ, the furthest E., η. A line from η to ϵ and 9° on reaches a point 1½° S. of ζ (3). 5° N. and 2° W. of α is θ (4).

CANIS MINOR.—β is the third-mag. star $4\frac{1}{2}°$ N.W. of α.

CAPRICORNUS.—Draw a line from Fomalhaut through ϵ Pisc. Aust., the fourth-mag. star, $5\frac{1}{4}°$ N.W. of it, and $17\frac{3}{4}°$ on. It will reach a fourth-mag. star, the easternmost of three such stars, which form a straight line from E. to W. $8\frac{1}{2}°$ long. They are, in that order, γ, ι, and θ. β is the third-mag. star about $1\frac{1}{2}°$ E., a little N. of γ. The fourth-mag. star $5\frac{1}{2}°$ S., a little E. from ι, is ζ. A line from ι to θ and $11°$ on will reach a point $3\frac{1}{2}°$ S. of a third-mag. star, which is β, and $2\frac{1}{2}°$ N. of β is α.

CASSIOPEIA.—The well-known "Chair" is composed as follows: Dividing its six stars into *feet*, *seat*, and *back*, we find that the feet are α (South) and β (North); the seat, γ (S.) and κ (N.); the back, δ (S.) and ϵ (N.). ζ and θ are two fourth-mag. stars, which form a scalene triangle with α; θ being $4°$ S.E. of α, and ζ $3°$ S. of α.

CEPHEUS.—This constellation is marked by an irregular square of four third-magnitude stars, the longest diagonal of which square is about $12°$. On the W. side of the square the star nearest the pole is β, the other α. On the E. side the star nearest the pole is ι, the other ζ. $11\frac{1}{2}°$ N.E. of β is γ (3). $2\frac{1}{2}°$ due E. of ζ is δ (4). $4°$ W., a trifle S. from α, is η (4).

CETUS.—$26°$ S.W. of Aldebaran is α (3). $5°$ W., a little S. from α, is γ (3). $8\frac{1}{2}°$ exactly S.W. from γ is o. A line from γ to o, and $10°$ on, reaches ζ (3). $10\frac{1}{2}°$ due W. from ζ is η (3). $2°$ N. of a line from ζ to η is θ (3). $10°$ S.W. of η is β (3). $11°$ N.W. of β is ι (3). The alignments here sound difficult, but they are in reality very easy, as the constellation contains so few conspicuous stars.

CORONA BOREALIS.—18° due W. and 7½° N. from Arcturus—20° from it—is a second-mag. star, which is α. Two fourth-mag. stars lie just E. of it, forming with it a line 3½° long. The nearest to α is γ, the other δ.

CORVUS.—A line drawn S.W. from Spica 17½° will reach the centre of the square of third-mag. stars marking Corvus. The western stars of the square are γ (N.) and ϵ (S.); the eastern, δ (N.) and β (S.).

CRATER.—This asterism adjoins Corvus on the W. It contains one third-mag. star, which is δ; 6° S.W. of δ is α (4).

CYGNUS.—The cross in this constellation is made up as follows: In the centre is γ; furthest N., α; furthest S., β. In the cross-piece: furthest E., ϵ; furthest W., δ. 6½° S.E. of ϵ is ζ (3). 5° N. of ζ is ν (4). About 8° N., somewhat W. of δ, are two fourth-mag. stars nearly 3° apart. The nearest to δ is ι, the other κ. A line from ζ to ν, and 11½° on, will reach ρ (4).

DRACO.—Draw a line from Polaris to Wega; 22½° from the former the line will pass 3° W. of a third-mag. star, which is δ. 17½° S.W. of δ will be seen a trapezium composed of two third-mag., one fourth-mag., and one second-mag. stars. The eastern of these are ξ (N.) and γ (S.); the western, ν (N.) and β (S.). γ and ν point to a third-mag. star 11½° N.W., which is η.

ERIDANUS.—1½° W., a little S. from Rigel, is a fourth-mag. star, which is λ. 3½° almost due N. of λ is β (3). A line from the middle of Orion's belt through β, and 19° on, reaches γ (3). The two third-mag. stars N.W. of γ are δ (E.) and ϵ (W.); and 9° nearly due W. of ϵ is η.

GEMINI.—8° S.W. of Pollux is δ (3). 12° from δ on line to Betelgeuse is γ (3). 7½° N.W. of γ will be seen two third-mag. stars, which are μ (E.) and η (W.). 4°

S.E. of γ is ξ (4). 12° due N. of ξ is ϵ (3). 4° W., a little S. from δ, is ζ (4).

HERCULES.—A line from Wega drawn W. and a little S. 20° will reach the centre of a large trapezium of four third-mag. stars. Of these the eastern members are π (N.) and ϵ (S.); the western, η (N.) and ζ (S.). 11½° due S. of π is δ (3), and the same distance due S. of δ is α. π and ϵ, and also η and ζ, point to a spot 2° E. of β (2). 3° S.W. of β is γ (3).

HYDRA.—About 13° E., a trifle N. from Procyon, are two third-mag. stars 2½° apart. They are ζ (E.) and ϵ (W.). 17° S.E. of these is α (2). On the W. border of Crater is a third-mag. star, which is ν, and 5½° nearly due E. of ν is μ (4). γ is the fourth-mag. star, 12° S., a trifle W. from Spica.

LEPUS.—This asterism is S. of Orion. It contains only two third-mag. stars, which are α (N.) and β (S.).

LEO.—The six stars forming the Sickle, counting from Regulus, are α, η, γ, ζ, μ, and ϵ. β (2) is 25° E., a little N. from α. ξ is a fifth-mag. star 9° nearly due W. of α.

LIBRA.—A line drawn 27° due E. from Spica reaches a point 2° S. of a third-mag. star, which is β. 9½° exactly S.W. from β is α (3).

LYRA.—S. and somewhat E. from α about 6½° are two third-mag. stars 2° apart. They are γ (E.) and β (W.). 7° due E. of α are two fourth-mag. stars less than 2° apart. They are η (N.) and θ (S.).

OPHIUCUS.—16° N., a trifle E. from Antares, is ζ (3); and N.E. of Antares about 14° is η (3). 9½° S. and 2½° E. from η is θ (4). α is the second-mag. star furthest N. in the constellation. 8½° S., a little E. from α, is β (3). κ (3) is 9½ E. and considerably S. from α, forming with it and β a scalene triangle. γ (4) is 2° S.E. from β.

ORION.—γ (2) is at the N.W. corner of the great quadrilateral, and κ (3) at the S.E. The stars in the belt, from W. to E., are δ, ϵ, and ζ. The fourth-mag. 3° from δ, almost on the line to Rigel, is η; and the northernmost of the three stars in the head is λ.

PEGASUS.—A line from Altair E., a trifle N., 28° will reach a second-mag. star, which is ϵ. 7° S.E. of ϵ is θ (3). 9½° N.E. of θ is ζ (3). 7° N.E. of ζ is α (2). 13° due N. of α is β (2). 17° due E. of α is γ (3).

PERSEUS.—α (2) is the brightest star in this constellation, and is 20° E. and somewhat N. from Capella. It lies nearly midway between two third-mag. stars, forming with them a curved line about 8° long. They are γ (N.) and δ (S.). 12½° nearly due S. of γ is β. 9° nearly due E. of β is ϵ (3). 8° nearly due S. of ϵ is ζ (3). 3½° due N. of β is κ (4).

PISCES.—α can only be aligned from a neighboring constellation. It is a third-mag. star 10° nearly due W. of γ Ceti.

SAGITTA.—A line from Wega through γ Lyræ and 17½° on reaches two fourth-mag. stars about 1° apart. They are α (N.) and β (S.).

SAGITTARIUS.—23½ E. and 4° S. from Antares is a third-mag. star, which is γ. 3¾° E. of γ, a trifle N., is δ (3). 5° N.E. of δ is λ (3). 6⅝° E., a little S. of λ, is σ. 6½° N.E. of σ is π (3). 4° S. and 2° E. of σ is ζ (3). 6° N.W. of λ is μ (4).

SCORPIO.—2½° N.W. of Antares is σ (3), and 6° further, in the same line, is δ (3). β (2) is 3° N.E. of δ. 21° W., a little N. from Antares, is γ (3).

SERPENS.—22° N. and a little W. from Antares will be found two third-mag. stars 1½° apart, which belong to Ophiucus. 12° N.W. from these will be found a similar

but wider pair. These are α (2) and ϵ (3). 8° due S. of ϵ is μ (3). 1° N.E. of α is λ (4). 9° nearly due N. of α is β (3). 9½° S. and 2½° W. from ζ Aquilæ is θ (4), and 11° S.W. of θ is η (4).

TAURUS.—11½° due N. of the group in Orion's head is ζ (3). 8° N. and 3° W. of ζ is β (2). 7° N., a little E. from α, is τ (4).

TRIANGULUM.—7½° S., a little E. from γ Andromedæ, is β (3). 7½° S.W. of β is α (4).

URSA MAJOR.—The stars in the "Dipper," from the Pointer nearest the Pole, are α, β, γ, δ, ϵ, ζ, and η. A line from δ to β and about 20° on will pass near two third-mag. stars 1½° apart. These are ι (N.) and κ (S.). 6° N.E. of them is θ (3). About 12° S.E. of θ is another pair of third-mag. stars, which are λ (N.) and μ (S.). A line from Polaris through the "Dipper" bowl and about 22° on will reach a third pair of stars, mags. 3 and 4, of which the northern one is ν.

VIRGO.—6° N.W. from Spica is θ (4). 8° N.W. from θ is γ (3). 5½° W. of γ is η (3). 7½° W. and somewhat N. from η is β (3). 6° N.E. of γ is δ (3), and 8° N., a little E. from δ, is ϵ (3).

A DESCRIPTIVE CATALOGUE OF FOUR HUNDRED AND SIXTY-EIGHT CELESTIAL OBJECTS.

ANDROMEDA.

An extensive northern constellation. Mean R. A., 12h. 50m.; Dec., + 26°; stars, 226.

α. (Alpheratz.) R. A., oh. 2m. 41s.; Dec., + 28° 29.2′. A difficult double. A 2, white; B 11, purplish. D., 70.2″.

β. (Merach.) R. A., 1h. 3m. 34s.; Dec., + 35° 2.3'. A bright star, with distant companion. A 2, fine yellow; B 10, pale blue. D., 304".

γ. (Almaack.) R. A., 1h. 57m. 8s.; Dec., + 4° 48.1'. A splendid double; really triple, but not in a small telescope. A 3½, orange; B 5½, emerald green. D., 10.1".

δ. R. A., 0h. 33m. 26s.; Dec., + 30° 15.5'. A bright star, with a difficult distant companion. A 3, orange; B 10, dusky. D., 229.1".

π. R. A., 0h. 31m. 0s.; Dec., + 33° 6.8'. A fine double. A 4½, fine white; B 9, blue. D., 35.1". Line from *α* Pegasi to *α* Andromedæ and 8° beyond, a trifle to the N.

4 Birm. R. A., 0h. 14m. 5s.; Dec., + 44° 5.9'. A fine red eighth-mag. star. Line from *α* Cassiopeæ to *ζ* Cass. and 10° on.

56. R. A., 1h. 49m. 37s.; Dec., + 36° 42.2'. A neat double. Both 6, both yellow. D., 181.6". Probably a binary. 6° from *γ* on line to *α* Trianguli.

240 P. XXIII. R. A., 23h. 52m. 28s.; Dec., + 23° 44.3'. A fine double. A 8½, pale white; B 9, yellowish. D., 9.1". Knott, in 1862, pronounced B "most decidedly blue." Line from the sword-handle of Perseus through *α* and 5° on.

R. R. A. (1880), 0h. 18m.; Dec., + 37° 55'. A rich orange star, which varies in 405 days from about mag. 6 to invisibility. About 10° from *α* on line to *θ* Cass.

31 M. (H., 116.) R. A., 0h. 36m. 47s.; Dec., + 40° 40.1'. The Great Nebula in Andromeda, justly described by Smyth as "overpowering." Under favorable circumstances it can be seen by the naked eye as a faint cloudy spot. In shape it is somewhat oval, with considerably greater brilliancy at the centre than at the edges. Its light probably requires about 6,000 years to reach us. It

has never been resolved, but, according to Huggins, is not gaseous. Its spectrum, however, is suddenly cut off at the red end—a most mysterious and inexplicable circumstance.

This nebula has a small nebula (32 M.), 25′ S. of it, of much feebler light. The major axis of the Great Nebula is about 40′ in length, and the minor axis about 15′. $1\frac{1}{2}°$ due W. of ν.

32 ♅ VII. (H., 457.) R. A., 1h. 51m. 14s.; Dec., +37° 7.6′. A large, rich cluster, about 30′ in diameter. Line from α to β and 8° on.

Anser et Vulpecula (The Goose and Fox).

A modern constellation constructed by Hevelius. Mean R. A., 20h.; Dec., + 25° ; stars, 126.

6 and 8. R. A., 19h. 24m. 8s.; Dec., +24° 26.6′. A pair of stars. A 4, deep yellow ; B 5, yellowish. D., 403.5″. Line from Altair through α and β Sagittæ and $7\frac{1}{2}°$ on.

2504 Σ. R. A., 19h. 16m. 9s.; Dec., + 18° 56.4′. An interesting double. A $6\frac{1}{2}$, yellowish white ; B $8\frac{1}{2}$, bluish. D., 8.9″. Dunér found these stars sometimes white, sometimes yellow. Line from Wega midway between β Lyr. and γ Lyr. and 16° on.

320 P. XIX. R. A., 19h. 48m. 31s.; Dec., + 20° 3′. A wide double. Both 7, both white. D., 42.3″. Line from Wega to β Cygni and 9° on.

2769 Σ. R. A., 21h. 5m. 35s.; Dec., + 22° 0.4′. A pretty double. A 7, B 8, both white. D., 18.2″. Line from α Cephei through ε Cygni and 8° on.

R. R. A. (1880), 20h. 59m.; Dec., + 23° 21′. A red star, variable in about 140 days from mag. 8 to invisibility with

the most powerful telescope. 2° from last object on line to γ Lyræ.

21 ♅ VIII. (H., 4497.) R. A., 19h. 22m. 34s.; Dec., +24° 55.1′. A large straggling cluster, whose brightest members assume the form of a Greek Ω. 3° from β Cyg. on line to Altair.

27 M. (H., 4532.) R. A., 19h. 54m. 48s.; Dec., + 22° 25′. The singular "Dumb-bell" Nebula. This extraordinary binuclear nebula has, in a small telescope, an oval shape, but it bears magnifying well, and with a good 2½-inch glass the duplicity of the nucleus may be seen. It is 14° from Altair on line to α Cephei.

Antinoüs.

A constellation frequently joined with Aquila. Mean R. A., 19h. 35m.; Dec., – 3 ; stars (with Aquila), 276.

274 P. XVIII. R. A., 18h. 57m. 5s.; Dec., –0° 51.9′. A double star; triple in large instruments. Both 9, both white. D., 23.8″. 4° from λ, a trifle E. of a line from λ to θ Serpentis.

2654 Σ. R. A., 20h. 9m. 24s.; Dec., –3° 50.4′. A beautiful double. A 6½, B 8½. Both white, according to Smyth, but according to Webb, yellow and blue. D., 11.8″. Line from Altair through θ Aquilæ and 2½° on.

140 P. XX. R. A., 20h. 21m. 46s.; Dec., – 2° 28.3′. A wide double in a very fine field. A 7½, B 8, both white. D., 59.6″. Line from ϵ Pegasi to θ Aquilæ and 3° on.

11 M. (H., 4437.) R. A., 18h. 45m. 13s.; Dec., – 6° 24.1′. A splendid cluster, nebulous in a small telescope. Smyth likens it in shape to a flight of wild ducks. 3¾° from λ on line to η Ophiuci.

AQUARIUS (THE WATER-BEARER).

A not very conspicuous constellation, containing no stars above the third magnitude, but astronomically important owing to its position in the Zodiac and its telescopic richness. Mean R. A., 21h. 50m.; Dec., – 10°; stars, 343.

τ^2. R. A., 22h. 43m. 47s.; Dec., – 14° 10.3′. A beautiful orange-red star, with a distant bluish companion of mag. 9. The primary is of mag. 5—a lovely object. D., 133.4″. 2⅜° from δ on line to γ.

ψ^1. R. A., 23h. 10m. 7s.; Dec., – 9° 41.3′. A beautiful double. A 5½, orange tint; B 9, sky blue. D., 49.9″. γ Capricorni and δ Capr. point to this object, 22½° from the latter.

R. R. A. (1880), 23h. 38m.; Dec., – 15° 57′. A deep-red star, variable in about 390 days from mag. 6 to 12½. Line from δ Capr. to δ Aquarii and 12½° on.

29. R. A., 21h. 56m. 25s.; Dec., – 17° 29.7′. A beautiful close double. Both 7, both white. D., 3.6″. Line from ι Capr. to γ Capr. and 5½° on.

41. R. A., 22h. 8m. 14s.; Dec., – 21° 37.3′. An elegant double. A 6, topaz yellow; B 8½, cerulean blue. D., 5.1″. 8½° from δ Capr. on line to Fomalhaut.

53. R. A., 22h. 20m. 34s.; Dec., – 17° 18′. A beautiful double. Both 6½, both pale white. D., 7.8″. Line from ι Capricorni to γ Capr. and 11½° on.

94. R. A., 23h. 13m. 18s.; Dec., – 14° 3.4′. A lovely double. A 6, pale rose tint; B 8½, light emerald. D., 13.8″. 6½° from δ on line to ι Ceti.

107. R. A., 23h. 40m. 18s.; Dec., – 19 17.5′. A very beautiful double. A 6, bright white; B 7½, blue. D., 5.8″. Line from γ to λ and 17° on.

2913 Σ. R. A., 22h. 24m. 45s.; Dec., – 8° 40.7'. A pretty double. A 7½, white; B 8½, reddish. D., 7.9". 7½° from γ on line to Fomalhaut.

219 P. XXII. R. A., 22h. 42m. 10s.; Dec., – 4° 47.8'. A triple star. A 7½, yellow; B 8, C 9, both flushed white. D., AB 3.8", AC 48.6". 6½° from ζ on line to ψ.

1 Ⅲ IV. (H., 4628.) R. A., 20 h. 58m. 10s.; Dec., – 11° 47.7'. A planetary nebula of a pale-blue color, bright to its edges and about 20" in diameter. "One of the finest specimens of these extraordinary bodies." (Webb.) Owing to its appearance in his telescope, Lord Rosse called this the Saturn nebula, and Lassell saw it as an elliptical ring with a star in the centre. It yielded to Dr. Huggins a gaseous spectrum. According to Sir John Herschel, if this object be only as far distant from us as the stars—and its distance is probably enormously greater—its dimensions must be such as would fill the whole orbit of Uranus. A globular body of such size could contain more than sixty-eight thousand millions of globes as large as our sun. 1° due W. of ν.

2 M. (H., 4678.) R. A., 21h. 27m. 44s.; Dec., – 1° 19.1'. A fine globular cluster, nebulous in all but large telescopes. The total light yielded by it does not exceed that of a star of the sixth magnitude. In the Herschel telescope it resembled a heap of fine sand. Huggins finds it gaseous. Diameter, 5' or 6'. Line from ζ Capricorni to β Aquarii and 5° beyond.

AQUILA (THE EAGLE).

A rich and beautiful constellation, lying directly in the Milky Way. It is frequently joined with Antinoüs as one

asterism. Mean R. A., 16h. 20m.; Dec., + 10; stars (with Antinoüs), 276.

α. (Altair.) R. A., 19h. 45m. 24s.; Dec., + 8° 34.2'. A brilliant star with a distant companion. A 1½, pale yellow; B 10, violet tint. D., 156.1". Will be found very difficult in a small telescope.

β. (Alshain.) R. A., 19h. 49m. 54s.; Dec., + 6° 8.3'. A star with several small companions. Mag., 3½. The principal companion is of mag. 10, pale gray, and presents a singular contrast to the delicate orange of the primary. D., 151.7". Difficult.

R. R. A. (1880), 19h. 1m.; Dec., + 8°.3'. A deep-red star, varying in 345 days from mag. 6.5 to 11. (Argelander.) 5⅔° from *δ* on line to *λ*.

T. R. A., 18h. 40m. 26s.; Dec., + 8° 38.1'. A pale ruby star, varying in about four months from mag. 9 to 9½. 7° from *ε* on line to *η* Serpentis.

15. R. A., 18h. 59m. 9s.; Dec., − 4° 11.7'. A fine double. A 6, yellowish; B 7½, lilac. D., 37.1". Other stars in field. 1° N., a little W. of *λ*.

57. R. A., 19h. 48m. 40s.; Dec., − 8° 30.8'. A fine double. A 6½, B 7, both blue according to Smyth, but observers differ to a remarkable extent as to these colors, and Webb urges telescopists to watch this pair. D., 35.6". Line from *α* to *η* and 9½° on.

483 Birm. R. A., 18h. 55m. 32s.; Dec., − 5° 50.9'. A very deep-red star of mag. 7½. "A fine specimen of a remarkable and beautiful class." (Webb.) 1½° S.W. of *λ*.

302 P. XVIII. R. A., 19h. 0m. 25s.; Dec., + 6° 23'. A very neat double. A 7½, lucid white; B 9, cerulean blue. D., 9.9". Line from *η* to *θ* Serpentis and 4° on.

241 P. XIX. R. A., 19h. 37m. 26s.; Dec., + 8° 7.3'.

A delicate double. A $7\frac{1}{2}$, pale topaz; B $9\frac{1}{2}$, lilac. D., 26.7′. It is 4° E. and a little S. from α, and just above μ, a fifth-mag. star.

43 P. XX. R. A., 20h. 8m. 46s.; Dec., + 6° 14.8′. A double star. A 6.8, B 7.2, both lucid white. Line from α to ξ, the fifth-mag. star, 1° S.E. of it and 5° on.

47 Ⅵ I. (H., 4441.) R. A., 18h. 47m. 7s.; Dec., – 8° 50.1′. A globular cluster 6′ in diameter. The component stars are small, and the cluster is less bright toward the centre. A line from δ through λ and $4\frac{3}{4}$° further on will reach a point 40′ S.E. of this cluster.

19 Ⅷ VII. (H. 4470.) R. A., 19h. 2m. 19s.; Dec., + 4° 3.4.′ A large and rich cluster of stars from mag. 12 to 14. A line from δ Aquilæ to θ Serpentis will pass about 1° S. of it, $4\frac{1}{2}$° from the former star. Difficult.

2035 h. (H. 4482.) R. A., 19h. 11m. 11s.; Dec., – 1° 6.9′. A loose, splashy cluster of stars from mag. 9 to 12. Rather difficult in a small telescope. $4\frac{1}{2}$° from δ on line toward λ.

4473 H. R. A., 19h. 5m. 52s.; Dec., + 0° 51′. A remarkable faint nebula, which, according to Hind, is variable. It is $2\frac{1}{2}$° N. E. of the last object, on a line toward θ Serpentis.

Argo Navis (The Ship Argo).

A grand constellation, most of which is below the horizon in every part of the United States, much more in England. Mean R. A., 9h.; Dec., – 55°. Stars, 540 according to Bode, and 1,330 according to Sir T. Brisbane.

149 P. VII. R. A., 7h. 29m. 40s.; Dec., – 23° 14.1′. A splendid double. Both mag. 6, both topaz. D., 9.″ Line from Pollux to Procyon and 28° beyond, or from Orion's sword through Sirius and 14° on.

1138 Σ. R. A., 7h. 40m. 26s.; Dec., – 14° 25.4′. A double star. A 7, silvery white; B 7½, pale white. Line from α Leporis through Sirius and as far again to the E. Almost in the field is 4 Argo Navis, a yellow 5th mag. star.

15219 Lalande. R. A., 7h. 42m. 45s.; Dec., – 15° 44.5′. A fine pair of stars. Both mag. 6½, both deep orange. D., 127.8″. A line from β Canis Majoris carried 1° S. of Sirius and 15½° further on will strike it.

72 P. VIII. R. A., 8h. 20m. 18s.; Dec., – 23° 41.3′. A beautiful double. A 6, red; B 9½, green. D., 41.9″. Line from Rigel to Sirius and 25½° beyond, and another at right angles N. W. 2°.

35 ♅ VIII. (H. 1521.) R. A., 7h. 18m. 54s.; Dec., – 13° 2.9′. A cluster large but little condensed, consisting of rather large stars. Line from β Canis Majoris through Sirius and 15° beyond.

38 ♅ VIII. (H. 1551.) R. A., 7h. 31m. 33s.; Dec., – 14° 14.3′. A splendid field of stars, somewhat lozenge-shaped, about 15′ in diameter, and led by a fiery red 7th mag. star. It contains a double star, A 7½, B 8, both bluish white. D., 7.3″. Line from β Can. Majoris, just under Sirius, and 13° beyond.

46 M. (H. 1564.) R. A., 7h. 36m. 47s.; Dec., – 14° 27.3′. A noble though rather loose cluster, more than 30′ in diameter, composed of stars from mag. 8 to 13, making a splendid glow. It contains a delicate double, A 8½, B 11, both white. D., 15″. "The impression left on the senses is that of awful vastness and bewildering distance." This object is 1° 20′ W. and a little S. of the last mentioned.

64 ♅ IV. (H. 1567.) R. A., 7 h. 36m. 59s.; Dec., – 17° 56.6′. A bright planetary nebula. With a power of 64 it resembles a dull 8th mag. star. With higher powers

it presents a bright undefined disk. Line from ζ Can. Maj. through Sirius and 14° beyond.

93 M. R. A., 7h. 39m. 51s.; Dec.,—17° 56.6′. A small galaxy cluster 8′ in diameter. The components range in magnitude from 7 to 12, and the group is compared by Smyth to a star-fish. Line from Orion's sword-cluster through Sirius and 16° beyond. "The unlucky Chevalier d'Angos, of the Grand Master's Observatory at the summit of the palace at Malta, mistook this object for a comet; from which, and even still more suspicious assertions, my excellent friend Baron de Zach was induced to term any egregious astronomical blunders *Angosiades*." (Smyth.)

11 H VII. (H. 1630.) R. A., 8h. 5m. 31s.; Dec.,—12° 32′. A large and loose but rich field. A close double in the centre, and a bright yellow 6th mag. star *sf*. Line from β Can. Maj. just below Sirius and 21½° further on.

63 H VII. (H. 1678.) R. A., 8h. 32m. 34s.; Dec., —29° 33.6′. A compressed cluster. Line from Rigel through Sirius and 30½° beyond.

ARIES (THE RAM).

An inconspicuous, but astronomically important constellation. Mean R. A., 2h. 25′; Dec., + 13°; stars, 148.

α. (Hamal.) R. A., 2h. 0m. 58s.; Dec., + 22° 56′. A star with a telescopic companion. A 3, yellow; B 11, purple. Difference of R. A., 19.5s.

β. (Sheratan.) R. A., 1h. 48m. 33s.; Dec., + 20° 16.2′. A pretty double, but will prove decidedly difficult in a

small telescope. A 3, pearly white; B 11, dusky. Difference of R. A., 7.4s.

γ. (Mesarthim.) R. A., 1h. 47m. 29s.; Dec., + 18° 45.3'. A fine double. A 4½, white; B 5½, pale gray. D., 8.32".

λ. R. A., 1h. 51m. 47s.; Dec., + 23° 3.6'. A fine double. A 5½, yellowish white; B 8, blue. D., 37.5". This star is the apex of an oblique triangle of which α and β form the base.

14. R. A., 2h. 3m. 9s.; Dec., + 25° 25.3'. A beautiful triple. A 5½, white; B 10½, blue; C 9, lilac. D., AB 82.6", AC 106.5". This star is 2° 40' N. and a little W. of α.

30. R. A., 2h. 30m. 37s.; Dec., + 24° 10.2'. A fine double. A 6, topaz yellow; B 7, pale gray. D., 38.3". Line from γ Pegasi through Hamal and 7° beyond.

41. R. A., 2h. 43m. 30s.; Dec., + 26° 48.5'. A coarse quadruple star, which our observer will probably see triple or even only double. A 3, white; B 13, deep blue; C 11, lurid; D 9, pale gray. D., AB 21.2", AC 34", AD 125.9". This star is the *lucida* of the scarcely recognized constellation *Musca Borealis*. 6½° from ϵ on line to γ Androm.

Auriga (The Charioteer).

A fine constellation, rich in telescopic objects. Mean R. A., 5h. 27m.; Dec., + 42°; stars, 239.

α. (Capella.) R. A., 5h. 8m. 33s.; Dec., + 45° 53.5'. A splendid star of mag. 1, bright white, with four distant companions, of which only one—E. 10, D. 158"—will be seen in a small telescope, and then only with much difficulty.

β. (Menkalinan.) R. A., 5h. 51m. 28s.; Dec., + 44° 56′. A beautiful star with a distant companion. A 2, lucid yellow ; B 10½, bluish. D., 184″.

θ. R. A., 5h. 52m. 12s.; Dec., + 37° 12.4′. A quadruple group. A 4, brilliant lilac ; B 7½, C 10, pale yellow ; D 9, yellowish. D., AB 2.08″, AC 45.5″, AD 125.1″.

λ. R. A., 5h. 11m. 22s.; Dec., + 40° 0.6′. A triple group. A 5, pale yellow ; B 13, C 9½, plum-color. D., AB 40.4″, AC 121.5″. Many stars in field. This star is about 5° from Capella on a line toward Bellatrix.

ω. R. A., 4h. 51m. 47s.; Dec., + 37° 43.4′. A beautiful double. A 4, pale red ; B 8, light blue. D., 5.9′. About one-third the distance between Capella and the Hyades.

26. R. A., 5h. 31m. 34s.; Dec., + 30° 25.6′. A fine double. A 5, pale white ; B 8, violet. D., 12.3″. Line from *ε* Orionis through *ζ* Tauri, and something less than 10° on.

41. R. A., 6h. 3m. 10s.; Dec., + 48° 44′. A neat double. A 6, silvery white ; B 7, pale violet. D., 7.7″. Line from *β* Tauri through *β* Aurigæ and 4° beyond.

56. R. A., 6h. 38m. 48s.; Dec., + 43° 41.1′. A double star. A 6, silvery white ; B 8½, lilac. Just north of a line from *α* through *β*, and extended as far beyond.

4 B. R. A., 4h. 31m. 41s.; Dec., + 26° 43.7′. A pretty double. Both mag. 7, both double. D., 3.7″. Line from Capella through *ζ* and 18° on.

96 B. R. A., 5h. 23m. 43s.; Dec., + 49° 18.3′. A neat double. Both mag. 8, both very white. D., 7.7″. About 4° from Capella on line towards *β* Urs. Maj.

2139 B. A. C. R. A. (1870), 6h. 27m. 36s.; Dec., + 38° 32.8′. A superb orange-red star, of mag. 6.5. Line from *α* 2½° E. of *β* and 8° further on.

33 H VII. (H. 1067.) R. A., 5h. 12m. 9s.; Dec., + 39° 13.7'. A rich field of small stars, the most prominent among which is a bright orange 7½ mag. star. About 7° from Aldebaran on a line towards Bellatrix.

39 H VII. (H. 1114.) R. A., 5h. 20m. 38s.; Dec., + 35° 13.3.' A compressed cluster about 3' in diameter, 12° from Capella on a line towards Betelgeuse. This cluster is in a rich neighborhood, there being no less than four others so near it that they may all be included in a circle 4° in diameter.

38 M. (H. 1119.) R. A., 5h. 22m. 2s.; Dec., + 35° 44.1'. A rich cluster 10' in diameter, very near the last-mentioned one towards the N. and a little W. The most clustering part forms an oblique cross with a pair of larger stars in each arm, and a conspicuous one in the centre. Line from Rigel through β Tauri and about 7° beyond.

36 M. (H. 1166.) R. A., 5h. 29m. 2s.; Dec., + 34° 4.2'. A splendid though open cluster; another of the above group. In the cluster is a neat double star. A 8, B 9, both white. D., 12". Line from middle of Orion's belt through ζ Tauri and about 13° beyond.

37 M. (H. 1295.) R. A., 5h. 45m. 2s.; Dec., + 32° 31.3'. A magnificent cluster, 24' in diameter. "The whole field strewed, as it were, with sparkling gold-dust." (Smyth.) "Extremely beautiful, one of the finest of its class. Gaze at it well and long." (Webb.) "Wonderful loops and curved lines of stars." (Rosse.) Line from Aldebaran through β Tauri and 7° on.

Boötes.

A fine and rich constellation. Mean R. A., 14h. 30m.; Dec., + 30°. Stars, 319.

α. (Arcturus.) R. A., 14h. 10m. 39s.; Dec., + 19° 45.7′. A magnificent star, usually rated as next to Sirius in brilliancy. It has a minute distant lilac companion of the 11th magnitude, which is quite beyond the powers of a small telescope.

δ. R. A., 15h. 11m. 3s.; Dec., + 33° 43.7′. Star with distant companion. A 3½, pale yellow; B 8½, light blue. D., 104.6″.

ε. R. A., 14h. 40m. 11s.; Dec., + 27° 32.2′. A famous and most beautiful double which Struve designated as "Pulcherrima." A 3, pale orange; B 7, emerald green, the colors in lovely contrast. D., 2.77″. Line from Mizar (ζ Urs. Maj.) through η Urs. Maj. to the star in question, which is about midway between Arcturus and α Coronæ Borealis.

κ. R. A., 14h. 9m. 31s.; Dec., 52° 18.1′. A fine double. A 5½, pale white; B 8, bluish. D., 12.9″. Line from ε Urs. Maj. through Mizar and 6° further on.

μ'. R. A., 15h. 20m. 21s.; Dec., + 37° 45.8′. A double in a small telescope, but triple in a larger one. A 4, flushed white; B 8, greenish white. D., 108.5″. A line from η Urs. Maj. through β Boötis and 4° beyond will pass within 1° of this star.

ξ. R. A., 14h. 46m. 18s.; Dec., + 19° 33.6′. A fine binary star. A 3½, orange; B 6½, purple. D., 4.19″. 8½° from α on line to β Serpentis.

π. R. A., 14h. 35m. 33s.; Dec., + 16° 53.5′. A fine double. A 3½, B 6, both white. D., 5.96″. 7° from Arcturus on a line towards α Serpentis.

44. R. A., 15h. 0m. 11s.; Dec., + 48° 5′. A remarkable and highly interesting binary with a period of about 261 years. A 5, pale white; B 6, lucid gray. D., 4.99″.

Sir W. Herschel calls this a miniature of Castor. $7\frac{1}{2}°$ from β on line towards the N. pole.

220 P. XIII. R. A., 13h. 45m. 12s.; Dec., + 21° 49.4′. A wide double. A $7\frac{1}{2}$, B 8, both flushed white. D., 85.8″. In the same field is 6 Boötis. This star is 6° from Arcturus towards Coma Berenices.

1850 Σ. R. A., 14h. 23m. 42s.; Dec., + 28° 46.7′. A pretty double. A $6\frac{1}{2}$, B 7, both very white. D., 25.2″. It is about 1° W. of a line from α to β, and 8° from the former.

CAMELOPARDUS.

A large but not very important or conspicuous modern constellation. Mean R. A., 5h.; Dec., 70°; stars, 211.

1. R. A., 4h. 19m. 23s.; Dec., + 53° 33.3′. A neat double. A $7\frac{1}{2}$, white; B $8\frac{1}{2}$, sapphire blue. D., 10.2″. Nearly midway between α Persei and δ Aurigæ.

97 P. III. R. A., 3h. 33m. 38s.; Dec., + 59° 36.8′. A lovely but rather difficult double. A 6, orange with scarlet glare; B 9, blue. D., 55.6″. 15° from δ Persei on line towards Polaris.

485 Σ. R. A., 3h. 58m. 15s.; Dec., + 62° 3.4′. A pretty double. Both $6\frac{1}{2}$; A white, B bluish white. D., 17.8″. Line from α Cassiopeæ through δ Cass. and 15° beyond.

269 P. IV. R. A., 5h. 4m. 26s.; Dec., + 79° 6.1′. A fine double. A $5\frac{1}{2}$, light yellow; B 9, pale blue. D., 20.2″. Line from β Draconis through Polaris and 10° on.

159 P. VII. R. A., 7h. 35m. 26s.; Dec., + 65° 24.9′. A fine double. Both mag. 8, both white. D., 15.6″. In a rich neighborhood. Line from Capella to δ Aurigæ and 15° beyond.

CANCER (THE CRAB).

A constellation of little brilliancy, but important from its position in the zodiac. Mean R. A., 8h. 25m.; Dec., + 8°; stars, 179.

θ. R. A., 8h. 25m. 20s.; Dec., 18° 28.1′. A star with a rather dull companion, which latter, however, is of interest on account of what seems to be a gradual decrease in its light. A 5½, yellow; B 9, gray. This is Smyth's rating, but Knott pronounces B of mag. 12, and suggests that it should be watched. D., 60.7″. A line from Regulus to *δ* Cancri and 3° beyond will come to a point 1° S. of this star.

ι. R. A., 8h. 40m. 3s.; Dec., + 29° 9.7′. A beautiful double. A 5½, pale orange; B 8, clear blue. The colors finely contrasted. D., 30.5″.

118 P. VIII. R. A., 8h. 32m. 48s.; Dec., + 20° 4′. A 8, B 8½, both pale white. D., 57.2″. About one-third the distance from Pollux to Regulus, about 2° south of a line so drawn.

124 P. VIII. R. A., 8h. 33m. 32s.; Dec., + 19° 56′. A fine triple. A 7, pale yellow; B 7½, dusky; C 6½, lucid white. D., AB 45.8″, AC 93.1″. About ½° E. and a little S. of the last object.

129 P. VIII. R. A., 8h. 34m. 6s.; Dec., + 20° 3.5′. A beautiful double. A 7, golden yellow; B 10, blue. D., 20.5″. Close to the east of the last object.

211 Birm. R. A., 8h. 49m. 11s.; Dec., + 17° 39′. A fine red star varying from mag. 7 to 7½. It is 1½° N. E. of a line from *α* to *δ*, at a point 3° from the latter.

194 B. R. A., 9h. 1m. 7s.; Dec., + 23° 24.9′. A pretty

double. Both $7\frac{1}{2}$, both white. D., 7.3″. Line from ξ Leonis through ε Leonis and 9° beyond.

44 M. (H. 1681.) R. A., 8h. 33m. 55s.; Dec., + 20° 19.4′. The Praesepe, a noble cluster of large dimensions, easily visible to the naked eye as a nebulous spot resembling a detached scrap of the Milky Way. It is a superb object in the telescope. Draw a line from Castor to Pollux and on to three times the distance between them.

67 M. (H. 1712.) R. A., 8h. 45m. 10s.; Dec., + 12° 12.7′. A rich clustering mass of stars of mags. 9 and 10, followed by a "crescent of stragglers." It is 2° W. of α.

CANES VENATICI (THE HUNTING DOGS).

A modern constellation formed by Hevelius. Mean R. A., 13h. 5m.; Dec., + 40°; stars, 139.

α. (Cor Caroli.) R. A., 12h. 50m. 53s.; Dec., 38° 54.7′. A fine double. A $2\frac{1}{2}$, flushed white; B $6\frac{1}{2}$, pale lilac. D., 20″.

2. R. A., 12h. 10m. 37s.; Dec., 41° 16.5′. A beautiful double. A 6, golden yellow; B 9, smalt blue. D., 11.5″. Line from Polaris through δ Ursæ Majoris, and 17° beyond.

1645 Σ. (1880.) A beautiful double, closely following a star (1642 Σ), in R. A., 12h. 20m.; Dec., + 45° 25′. A 7, B $7\frac{1}{2}$, both yellowish white. D., 10.4″. "A lovely pair as I ever saw." (Bird.) To find 1642 Σ, draw a line from α Ursæ Majoris through γ Urs. Maj. and $8\frac{1}{2}$° beyond.

94 M. (H. 3258.) R. A., 12h. 45m. 43s.; Dec., + 41° 43.3′. A comet-like nebula, 2.5′ in diameter. It is of a fine pale white color, brightening towards the centre. $2\frac{1}{2}$° from α, towards δ Ursæ Majoris.

96 H I. (H. 3437.) R. A., 13h 5m. 51s.; Dec., + 37° 39.2′. A large nucleated nebula, 6′ long, 1.5′ wide. Line from μ Ursæ Maj. to Cor. Caroli and 3½° beyond.

97 H I. (H. 3459.) R. A., 13h. 8m. 23s.; Dec., + 37° 10.8′. A bright large nebula, brighter towards centre. About ½° from the last object, S. and a little E.

63 M. (H. 3474.) R. A., 13h. 10m. 53s.; Dec., + 42° 36.7′. A faint oval nebula, 9′ or 10′ long, and nearly 4′ wide, with a nucleus like a small star. Line from β Leonis through Cor Caroli and 5½° beyond.

51 M. (H. 3572.) R. A., 13h. 35m. 13s.; Dec., + 47° 45.2′. A faint double nebula, with centres 4′ 45″ apart, but borders in contact. In a 5-inch telescope, the southern object "resembles a ghost of Saturn with its ring in a vertical position." This system bears, according to Sir John Herschel, a strong resemblance to our own. It is one of the most celebrated of the Earl of Rosse's spiral nebulæ. It lies 3° from η Ursæ Majoris, on a line from Polaris through ζ Urs. Maj.

3 M. (H. 3636.) R. A., 13h. 37m. 3s.; Dec., + 28° 55.3′. A brilliant and beautiful globular cluster of not less than 1,000 small stars, blazing towards the centre. A noble object, 5′ or 6′ in diameter. About 18° from ε Boötis on line drawn across the southern base of the cluster in Coma Berenices.

CANIS MAJOR (THE GREATER DOG).

A fine constellation, distinguished by including within its boundaries the brightest star in the heavens. Mean R. A., 7h.; Dec., – 30°; stars, 161.

α. (Sirius.) R. A., 6h. 40m. 18s.; Dec., – 16° 33.7′. The Dog-star, the most brilliant and splendid of all the heavenly host. It is a magnificent object in the telescope,

although a small instrument will fail to show even its principal companion. Mr. Proctor thinks this *comes* would be visible in a 3-inch telescope, but this is not at all in accord with my experience. Sir William Herschel says that the entrance of Sirius into the field of his 40-foot telescope was heralded by a dawning like that of a sunrise, and that its lustre when within the field was intolerable to the eye.

β. (Mirzam.) R. A., 6h. 17m. 52s.; Dec., – 17° 54.3′. A bright star with a companion. A $2\frac{1}{2}$, fine white; B 9, dusky gray. D., 185.2″. Another 9 mag. star in field.

δ. (Wezen.) R. A., 7h. 3m. 55s.; Dec., – 26° 13.1′. A star with companion. A $3\frac{1}{2}$, light yellow; B $7\frac{1}{2}$, very pale. D., 265.9″. Other small stars in field.

ε. (Adhara.) R. A., 6h. 54m. 18s.; Dec., – 28° 49.3′. A pale orange $2\frac{1}{2}$ mag. star, with a 9 mag. companion at a distance of 7.7″, and another of mag. 7 further off. Line from middle of Orion's belt through *β* and $14\frac{1}{3}$° on.

η. R. A., 7h. 19m. 44s.; Dec., – 29° 5.3′. A beautiful star with distant companion. A 3, pale red; B $7\frac{1}{2}$, dull gray. Two small stars following. D., 178.6″. Line from *β* through *δ* and 5° on.

ν^1. R. A., 6h. 31m. 33s.; Dec., – 18° 34.1′. A neat double. A $6\frac{1}{2}$, pale garnet; B 8, gray. D., 17.4″. Followed in *sf* by ν^2. It is 3° S.E. of Sirius, and $3\frac{1}{2}$° from Mirzam.

17. (π^2.) R. A., 6h. 50m. 18s.; Dec., – 20° 15.9″. A wide quadruple. A 6, flushed white; B $9\frac{1}{2}$, ruddy; C $9\frac{1}{2}$, ruddy; D 10, dusky. D., AB 45″, AC 52.5″, AD 125″. This is the middle one of three small stars about $4\frac{1}{2}$° S.S.E. of Sirius.

22. R. A. (1870), 6h. 56m. 32s.; Dec., – 27° 45′. A fine red star; mag., $3\frac{1}{2}$. It is $1\frac{1}{2}$° from *ε* on a line to *δ*.

—. R. A. (1870), 7h. 17m. 39s.; Dec., – 25° 30.8′. An intense fiery red star; mag., 7. A line from Bellatrix through Sirius and 13° on will come within 40′ S.E. of it.

41 M. (H. 1454.) R. A., 6h. 42m. 13s.; Dec., – 20° 37.8′. A scattered cluster in 5 groups, the central one the richest. A splendid object. It is 4° almost due S. of Sirius, a little to the E.

578 Dun. (H. 1463.) R. A., 6h. 45m. 5s.; Dec., – 35° 52.9′. A globular cluster brightening towards the centre. Line from Bellatrix through Mirzam, and 21° on.

12 ℍ VII. (H. 1512.) R. A., 7h. 12m. 51s.; Dec., – 15° 26.5′. A tolerably compressed but extensive cluster. It is a singular group of very lucid stars, nearly all of mag. 10. The most compressed part occupies about one-third of the field with a power of 66. Line from α Tauri through Bellatrix to a point 7½° W.N.W. of Sirius.

17 ℍ VII. (H. 1513.) R. A., 7h. 14m. 28s.; Dec., – 24° 45.2′. A beautiful cluster of slightly elongated form, consisting of a rich gathering of minute stars surrounding a bright white 6th mag. star. Line from ζ Orionis through Sirius and 12° on.

CANIS MINOR (THE LESSER DOG).

A small constellation, of which the principal interest centres in its *lucida*. Mean R. A., 7h. 27m.; Dec., + 7°; stars, 55.

α. (Procyon.) R. A., 7h. 33m. 33s.; Dec., + 5° 30.5′. A famous and beautiful star of mag. 1½, although it certainly deserves, in the opinion of many astronomers, to be rated higher. It has several companions, all of which are beyond the reach of a small telescope.

β. (Gomelza.) R. A., 7h. 21m. 11s.; Dec., + 8° 30.6′. A wide though difficult triple. A 3, white; B 12, orange; C 10, flushed. C itself is coarsely double, having a 10 mag. companion. D., AB 122.3″, AC 138.8″.

S. R. A., 7h. 26m. 45s.; Dec., + 8° 33.2′. A fiery red star, varying from 7½ to less than 12 mag. 1½ E. of *β*.

14. R. A., 7h. 52m. 39s.; Dec., + 2° 31′. A wide triple. A 6, pale white; B 8, bluish; C 9, blue. D., AB 75″, AC 115″. Line from *γ* Geminorum through Procyon and 4½° on.

Capricornus (The Goat).

A zodiacal constellation, rather dull to the naked eye, but of importance astronomically. Mean R. A., 20h. 40m.; Dec., – 18°; stars, 154.

α. (Giedi.) R. A., 20h. 11m. 57s.; Dec., – 16° 53.1′. A remarkable multiple object. α^1 and α^2 are 376.1″ apart. α^1 is composed of four stars, of magnitudes 3, 11, 11, and 9½; α^2 of three, of magnitudes 4, 9, and 14. A small telescope will probably not show more than four stars in the entire group.

β. (Dabih.) R. A., 20h. 14m. 50s.; Dec., – 15° 7.8′. A wide pair of stars. A 3½, orange yellow; B 7, sky blue. D., 205″.

o^2. R. A., 20h. 23m. 36s.; Dec., – 18° 56.7′. A fine double. A 6, B 7, both bluish. D., 22.1″. It is 2½° E. a little south from a group of 5th mag. stars, 4° from *β* on a line from *α*.

σ. R. A., 20h. 13m. 3s.; Dec., – 19° 27.8′. A star with telescopic companion. A 5½, yellow; B 10, violet. D., 54.1″. Line from *δ* ½° S. of *θ* and 11½° on.

545 Birm. R. A., 20h. 10m. 40s.; Dec., – 21° 39.3′. A lovely red star, probably variable, as the estimates of its magnitude vary from 6 to 7½. Sir J. Herschel says of it, "Pure ruby, perhaps the finest of my ruby stars." It is 8° 40′ almost due S. of *α*, and almost exactly three times as far from *α* as *β* is.

312 P. XX. R. A., 20h. 43m. 30s.; Dec., – 27° 46.4′. A beautiful double. A 7½, pale yellow; B 8½, blue. D., 18.7″. It is S. and a little W. from *ω*, a 4th. mag. star which is the southernmost of two 4th mag. stars, 2½° apart, about 14° S. E. of *α*.

72 M. (H. 4608.) R. A., 20h. 47m. 24s.; Dec., – 12° 56.6′. A globular cluster of very minute stars, about 1.53′ in diameter. Line from *α* Aquarii through *β* Aquarii and nearly 12° on.

73 M. (H. 4617.) R. A., 20h. 52m. 55s.; Dec., – 13° 3.6′. A rather poor field, which Smyth records out of regard to Messier's memory. It exhibits little compression. It follows the last object by about 5m. of R. A., and 7′ southward.

30 M. (H. 4687.) R. A., 21h. 34m. 7s.; Dec., – 23° 39′. A fine pale white cluster, nebulous in small telescope. It is somewhat elliptical, and brightens to a blaze in the centre. A line from *β* to *ζ* and 4° on will reach a point less than 1° S. of it.

CASSIOPEA.

A superb constellation, one of the richest in the heavens. Mean R. A., 0h. 55m.; Dec., + 60°; stars, 134.

α. (Shedir.) R. A., 0h. 34m. 16s.; Dec., + 55° 56.3′. A beautiful double. A 3, pale rose; B 9½, smalt blue.

D., 62.5″. A is considered variable by some astronomers.

β. (Caph.) R. A., oh. 3m. 18s.; Dec., + 58° 32.6′. A star with a distant companion. A 2½, whitish ; B 11½, dusky. D., 297″. Very difficult with a small telescope.

γ. R. A., oh. 50m. 4s.; Dec., + 60° 7.2′. A beautiful brilliant white 3d mag. star, with others in field.

η. R. A., oh. 42m. 26s.; Dec., + 57° 13.9′. A superb binary star. A 4, B 7½. D., 5.7″, and decreasing. The estimates as to the colors of the components differ considerably ; Smyth giving them as pale white and purple, and no less than six other colors being assigned to them by different observers. The latest estimate is yellow and red.

R. R. A., 23h. 52m. 49s.; Dec., + 50° 46.4′. A vivid red star with a minute blue companion 20″ distant. It varies in 426 days from mag. 5 to below mag. 12. Line from *δ* through *α* and 8° on.

4. R. A., 23h. 19m. 57s.; Dec., + 61° 40.7′. A double star in a small telescope ; in a larger one, quadruple. A 5, pale yellow ; B 9, yellowish. D., 98.1″. 2° due N. of *β*.

9. R. A., 23h. 58m. 33s.; Dec., + 61° 40.5′. A pair of stars ; in a large telescope, a group of four. A 6, white ; B 8, deep yellow. D., 244″. 2° E. and somewhat N. from *γ*.

1 Birm. R. A., oh. 3m. 38s.; Dec., + 63° 20.4′. A fine ruby star. Mag., 8½. About 1¼° due N. of *β*.

163 Σ. R. A., 1h. 43m. 17s.; Dec., + 64° 18.1′. An exquisite double. A 6½, golden red ; B 9, blue. D., 34 9″. 9° from *θ* on line to Polaris.

101 P. XXIII. R. A., 23h. 24m. 56s.; Dec., + 57° 56.6′. A remarkable multiple star, which, however, our

observer will only see double. A 5, light yellow; B 7½, white. Line from δ to γ and 12° on.

3053 Σ. R. A., 23h. 56m. 57s.; Dec., + 65° 29'. A beautiful double. A 6, very yellow; B 8, blue. D., 15". Line from γ Andromedæ to γ Cassiopeæ and 8° on.

159 ♅ I. (H. 158.) R. A., 0h. 45m. 50s.; Dec., + 46° 57.9'. An "almost planetary" nebula, 20" in diameter. Line from Polaris to β and 11½° on.

103 M (H. 341.) R. A., 1h. 25m. 56s.; Dec., + 60° 7.1'. A brilliant and beautiful fan-shaped cluster. About 1¼° E. and a little N. of δ.

31 ♅ VI. (H. 392.) R. A., 1h. 38m. 39s.; Dec., + 60° 41.3'. An elegant, irregular cluster. About 2° from last object on line from δ.

30 ♅ VI. (H. 5031.) R. A., 23h. 51m. 35s.; Dec., + 56° 6.2'. A splendid galaxy cluster of minute stars; "a very glorious assemblage both in extent and richness; a mere condensed patch in a region of inexpressible splendor, spreading over many fields." Discovered by Miss Caroline Herschel. It is 2½° from β on a line towards Algol.

CENTAURUS (THE CENTAUR).

A large constellation, most of which is below the horizon in our latitudes, or so near it as to offer little opportunity for its study. Mean R. A., 13h. 35m.; Dec., — 50°. It presents to us but one object of interest.

83 M. (H. 3606.) R. A., 13h. 30m. 49s.; Dec., — 29° 18.8'. A large and bright nebula, nucleated in centre. In a large telescope it appears as a 3-branched spiral. Line from η Virginis to γ Hydræ and 8° on.

CEPHEUS.

A highly interesting northern constellation, although of little brilliancy to the naked eye. Mean R. A., 22h.; Dec., + 73°; stars, 294.

α. (Alderamin.) R. A., 21h. 15m. 56s.; Dec., + 62° 7.1′. A star with a difficult distant companion. A 3, white; B 10, pale blue. D., 208.9″.

β. (Alphirk.) R A., 21h. 27m. 14s.; Dec., + 70° 4.6′. A beautiful double. A 3, white; B 8, blue. D., 13.3″.

δ. R. A., 22h. 25m. 5s.; Dec., + 57° 51.1′. A lovely though wide double. A 4½, orange tint; B 7, fine blue, the colors well contrasted. A is variable from mag. 3½ to 4½. Its interval from maximum to minimum is 3d. 19h., and from minimum to maximum 1d. 14h. D., 19.3″.

κ. R. A., 20h. 12m. 35s.; Dec., + 77° 22.7′. A neat double. A 4½, bright white; B 8½, smalt blue. A fine object. D., 7.2″. A line drawn from *γ* Androm. through *δ* Cassiopeæ to within 12° of Polaris will find this star.

μ. R. A., 21h. 40m. 8s.; Dec., + 58° 16.5′. A richly colored star with two companions. It varies from mag. 4 to 6. Sir W. Herschel says: "It is of a very fine deep garnet color, . . . and a most beautiful object, especially if we look for some time at a white star before we turn our telescope to it, such as *α*, which is near at hand." It is 5° from *α* on a line towards *β* Pegasi.

ξ. R. A., 22h. 0m. 35s.; Dec., + 64° 5.4′. A splendid double. A 5, B 7, both blue. D., 6.6″. It is 7° from *β* on line towards *δ*.

248 P. XXI. R. A., 21h. 35m. 37s.; Dec., + 56° 59.5′. A neat triple. A 6, pale yellow; B and C both 8½, both

gray. D., AB 11.7″, AC 19.8″. A line from Polaris through β and 13° on will pass within ½° W. of this star.

256 P. XXI. R. A., 21h. 36m. 57s.; Dec., + 57° 5′. A very neat double. A 8, white; B 9, pale violet. D., 12.6″. Line from γ Cassiopeæ through β Cassiopeæ and 3° on.

147 B. R. A., 21h. 48m. 17s.; Dec., + 55° 16.8′. A pretty double. A 6, greenish white; B 7½, bluish white. D., 20.1″. Line from γ Cygni to α Cygni and 16° on.

2893 Σ. R. A., 22h. 10m. 54s.; Dec., + 72° 45.8′. A fine double. A 6, yellowish; B 8, white. D., 28.8″. About midway between β and γ.

U. R. A., 0h. 52m. 33s.; Dec., + 81° 17′. Ceraski's 2d variable, the most rapid yet known. It varies from mag. 7 to 9, and its periods of maximum, minimum, and change are 2 hours each. According to Knott, it is bluish at maximum and ruddy at minimum. I append a diagram (from Webb) which will assist in finding this star.

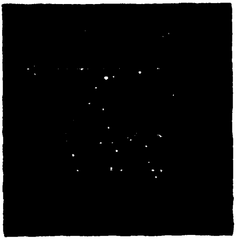

FIG. 13.

42 H VI. (H. 4590.) R. A., 20h. 29m. 17s.; Dec., + 60° 16.3′. A large and rich cluster of minute stars. 2° from η on line from ε Cassiopeæ.

52 M. (H. 4957.) R. A., 23h. 19m. 21s.; Dec., + 60° 59.5′. An irregular cluster, nebulous in a small telescope, but showing some stars. It is of a somewhat triangular form, with an orange-tinted 8th mag. star at one angle. At ⅓ the distance between β Cassiopeæ and α Cephei.

Cetus (The Whale).

The largest of all the constellations. Mean R. A., 1h. 35m.; Dec., – 18°; stars, 301.

α. (Menkab.) R. A., 2h. 56m. 31s.; Dec., + 3° 39.5′. A star with a distant companion. A 2½, bright orange; B 10, pale gray. Diff. of R. A., 29.6″. A fine blue 5th mag. star in field towards N.

η. R. A., 1h. 3m. 3s.; Dec., – 10° 45.9′. A probably variable star with distant companion. A 3½, yellow; B 10, lead color. D., 2.25″.

ζ. R. A., 1h. 46m. 2s.; Dec., – 10° 52.8′. A 3½, topaz yellow; B 9, white. D., 185″.

o. (Mira.) R. A., 2h. 13m. 47s.; Dec., – 3° 28.7′. A wonderful variable. It changes from mag. 2 to invisibility, according to Smyth; from mag. 2 to mag. 10, according to Webb; and from mag. 1.7 to mag. 8 or 9 on Struve's scale, according to Schönfeld. Its period is 331d. 8h. 14m. 16s., according to Argelander. Mira is about half-way between *γ* and *ζ*.

26. R. A., 0h. 58m. 9s.; Dec., + 0° 46.6′. A neat double. A 6½, pale topaz; B 9½, lilac tint. D., 16″. Midway between *γ* Pegasi and *ζ* Ceti.

37. R. A., 1h. 8m. 51s.; Dec., – 8° 30.7′. A fine though wide quadruple. A 6, white; B 7½, light blue; C 8, yellow; D 10, violet. D., AB 48.3″, CD 20.5″. It is 2½° almost due E. of *θ*, and 2° 40′ N. N. W. of *η*.

66. R. A., 2h. 7m. 8s.; Dec., – 2° 54.3′. A beautiful double. A 7, pale yellow; B 8½, sapphire blue. D., 15.35″. It is 1° 40′ W. and a little N. from Mira.

113 P. O. R. A., 0h. 28m. 52s.; Dec., – 9° 5.3′. A

fine double. A 7, cream yellow; B 9, smalt blue; D., 19.9″. 10° from β on line towards γ Pegasi.

146 P. O. R. A., oh. 35m. 6s.; Dec., – 4° 57.3′. A beautiful though wide double. A 6½, pale topaz; B 9, violet tint. D., 65″. Line from η to α Pegasi; the star will be found 9° from the former.

191 P. I. R. A., 1h. 46m. 11s.; Dec., + 10° 16″. A beautiful close double. A 7½, B 8, both lucid white. It is 13° from α Arietis (to which constellation it really belongs) on a line to θ Ceti. D., 3.6″.

150 Σ. R. A., 1h. 37m.; Dec., – 7° 42′. A beautiful double. A 8, B 8½, both very white. D., 36.2″. Line from ι through θ and 5° on will reach a point 40′ S. of it.

23 ℍ IV. (H. 544.) R. A., 2h. 21m. 57s.; Dec., – 1° 38′. A planetary nebula, bluish white, pale but very distinct. 7° from γ on line towards ζ.

77 M. (H. 600.) R. A., 2h. 37m. 3s.; Dec., – 0° 28.3′. A small bright round stellar nebula. It is 3½° due S. of γ.

Clypeus Sobieski (Sobieski's Shield).

A small modern constellation in the most brilliant portion of the Milky Way. Mean R. A., 18h. 23m.; Dec., – 10°.

24 M. (H. 4397.) R. A., 18h. 11m. 44s.; Dec., – 18° 26.8′. A superb field of small stars, nebulous in a small telescope. It really belongs to Sagittarius, and is 3° N. N. W. from μ Sag. Line from Altair to λ Antinoi, and as far again.

16 M. (H. 4400.) R. A., 18h. 12m. 34s.; Dec., – 13° 49.7′. A scattered but fine large stellar cluster. Line from γ Sagittarii to μ Sag. and 7° on.

18 M. (H. 4401.) R. A., 18h. 13m. 30s.; Dec., – 17° 10.8′. A somewhat long and straggling cluster of minute stars. It lies 4° from μ Sagittarii on a line towards ε Aquilæ. Webb calls it a glorious field in very rich vicinity, and adds, "South of it lies a region of surpassing splendor." (About 1°.)

17 M. (H. 4403.) R. A., 18h. 14m. 16s.; Dec., – 16° 14.9′. The singular and beautiful Horse-shoe or Omega nebula, "a magnificent arched and irresolvable luminosity," in a splendid field. It is pronounced gaseous by Huggins. It is 4½° from μ Sag. on line towards ε Aquilæ – ½° N. by E. from 18 M.

26 M. (H. 4432.) R. A., 18h. 39m. 11s.; Dec., – 9° 30.6′. A small and coarse but bright cluster. Line from β Herculis through β Ophiuci and 20½° on.

Coma Berenices (Berenice's Hair).

A constellation distinguished by the beautiful diffused cluster which forms its principal part. Mean R. A., 12h. 30m.; Dec., + 27°; stars, 117.

24. R. A., 12h. 29m. 36s.; Dec., – 18° 58.9′. A beautiful double. A 5½, orange; B 7, emerald tint, the colors very brilliant. D., 20″. A little less than 13° from β Leonis on line towards Arcturus.

202 P. XII. R. A., 12h. 46m. 29s.; Dec., + 20° 46.2′. A neat double. A 7½, B 8, both white. D., 15.7″. Line from Spica through ε Virginis and 9½° on.

92 H I. (H. 3101.) R. A., 12h. 30m. 29s.; Dec., + 28° 33.9′. A large club-shaped nebula, brightening towards the centre. It is 2½° from 15, a 4th mag. star (the largest in the cluster) in the extreme north of the Tresses, on a line towards Arcturus.

24 ℔ V. (H. 3106.) R. A., 12h. 30m. 50s.; Dec., + 26° 35.7′. A curious "streak" of nebulosity, shaped somewhat like a weaver's shuttle, and 15′ in length. It will be found difficult with anything under 4 inches. It lies just outside the Tresses, or principal cluster, to the E.

53 M. (H. 3453.) R. A., 13h. 7m. 30s.; Dec., + 18° 45.3′. A globular cluster of minute stars of mag. 11–15. "A ball of innumerable worlds." Line from Polaris through 43, the easternmost of the only two 4th mag. stars in the asterism, and 9½° on.

64 M. (H. 3321.) R. A., 12h. 51m. 19s.; Dec., + 22° 16.9′. A fine nebula, but difficult with small apertures. Bright nucleus. Line from Spica through ε Virginis and 11° on; then 1½° due E.

Corona Borealis (The Northern Crown).

A beautiful little constellation. Mean R. A., 15h. 35m.; Dec., + 28°; stars, 87.

α. (Alphecca, or Gemma.) R. A., 15h. 30m. 2s.; Dec., + 27° 5.1′. A beautiful star with a distant companion. A 2, brilliant white; B 8, pale violet. Difference of R. A., 11.6s.

ζ. R. A., 15h. 35m. 14s.; Dec., + 36° 59.7′. A beautiful double. A 5, bluish white; B 6, smalt blue. D., 6.3″. Line from ε Boötis through δ Boötis and 6° on.

ν. R. A., 16h. 12m. 20s.; Dec., + 29° 27.5′. A quadruple, but a small aperture will hardly show it more than double. A 6, B 10, C 9. D., AB 86.4″, AC 123.3″. 12° from β Herculis on line towards β Boötis.

T. R. A., 15h. 54m. 53s.; Dec., + 26° 14′. The famous "Blaze star" which in May, 1866, suddenly grew

from a 9th magnitude star to a 2d magnitude one. Probably a long-period variable. It is now of the 9th magnitude. α, γ, and δ form a line which, prolonged 2½ degrees beyond δ, will reach a point about ½° due S. of T.

Corvus (The Crow).

A small and not very important constellation. Mean R. A., 12h. 15m.; Dec., – 18°; stars, 61.

β. R. A., 12h. 28m. 36s.; Dec., – 22° 47.3'. A fine star with two distant companions. A 2½, ruddy yellow; B 7, greenish yellow; C 8, dull gray. Difference of R. A., AB 27.4s.; AC 28s.

δ. R. A., 12h. 24m. 11s.; Dec., – 15° 54.1'. A fine double. A 3, pale yellow; B 8½, purple. D., 22.9".

Crater (The Cup).

A diminutive constellation, but, like Corvus, one of the original 48. Mean R. A., 11h. 15m.; Dec., – 18°; stars 95.

α. (Alkes.) R. A., 10h. 54m. 27s.; Dec., – 17° 42.9'. A fine star, notable for its two beautiful companions in the field. A 4, orange tint; B 8, intense blood color; C 9, pale blue. B is the lovely star next described.

R. R. A., 10h. 55m. 8s.; Dec., – 14° 29.4'. A beautiful crimson or scarlet star, varying from mag. 8 to 9. Its color seems to be growing paler.

17. R. A., 11h. 26m. 49s.; Dec., – 28° 39.6'. A neat double. A 5½, lucid white; B 7, violet tint. D., 8.7". Line from Spica ½° under ε Corvi and about 11° on.

CYGNUS (THE SWAN).

A superb constellation, one of the finest in the northern heavens. Mean R. A., 20h. 17m.; Dec., + 41°; stars, 360.

α. (Deneb.) R. A., 20h. 37m. 40s.; Dec., + 44° 53.2'. A beautiful brilliant white star. It has a distant companion of mag. 12½, which is beyond the powers of a small telescope.

β. (Albireo.) R. A., 19h. 26m. 17s.; Dec., + 27° 43.7'. A lovely double, one of the finest in the skies. A 3, topaz yellow; B 7, sapphire blue, the colors in beautiful contrast. D., 34.8".

μ. R. A., 21h. 39m. 12s.; Dec., + 28° 15'. A beautiful double with a distant companion. A 5, white; B 6, C 7½, both blue. D., AB 3.84", AC 208.74". Distance AB is decreasing. A line from *ε* Cassiopeæ through *β* Cass., and 32° on, will reach it at a point 19° due N. of *ε* Pegasi.

o^2. R. A., 20h. 10m. 10s.; Dec., + 46° 24.5'. A wide triple in a small telescope, quadruple in anything over 5 inches. A 4, orange; B 7½, C 5½, both cerulean blue. D., AB 106.8", AC 337.8". C is o^1 Cygni. This group is 5° from Deneb, on a line to *γ* Draconis.

χ^2. R. A., 19h. 44m. 38s.; Dec., + 33° 9.7'. An extraordinary variable, with distant companion. It is of a splendid red color, and varies from mag. 5 (4, according to some observers) to invisibility in 406d. It takes about 3½ months in increasing from minimum to maximum brightness, and the same time in decreasing; after which it remains invisible for about six months. It is 8° from *β* on a line to *ν*.

χ^1. R. A., 19h. 42m. 15s.; Dec., + 33° 28.8'. A fine double. A 5, golden yellow; B 9, pale blue. D., 25.7". It is but 2m. 23s. W. of the above object, and 9.1' nearer the N.

16. R. A., 19h. 38m. 54s.; Dec., + 50° 16.2'. A fine double. A 6½, B 7, both fawn-color. D., 37.9". It is 1¼° from ι on line to α.

61. R. A., 21h. 1m. 57s.; Dec., + 38° 12.5'. A famous and most interesting double, perhaps a binary. A 5½, B 6, both yellow; the smaller one of deeper tint. D., 20.1". This was the first star the distance of which was determined. This was accomplished in 1838, by the illustrious Bessel of Königsberg. He ascertained its parallax to be 0.3136". A more recent determination is that of Auwers—0.56; and there is but one star which exhibits a larger parallax, namely, α Centauri. The distance of 61 Cygni is 366,400 times the distance of the earth from the sun, and its light occupies six years in traversing this stupendous interval. A line from Vega through γ Cygni and 10° on, reaches a point 1¼° due S. of 61; and a line from α through ν and prolonged 3½° strikes it.

R. R. A., 19h. 33m. 52s.; Dec., + 49° 57'. A red star, varying in 425 days from mag. 6 to 14. It is 12° from α towards γ Draconis.

6 B. R. A., 19h. 9m. 16s.; Dec., + 49° 37.9'. A pretty double. A 6½, B 7, both yellow. D., 9.8". 3½° due S. of κ.

149 P. XIX. R. A., 19h. 23m. 43s.; Dec., + 36° 18.4'. A very elegant double. A 8½, white; B 9, pale blue. D., 7.2". 8° from β on line towards κ.

276 P. XIX. R. A., 19h. 41m. 37s.; Dec., + 35° 49.4'. A neat double. A 8, B 8½, both white. D., 14.7". Line from Polaris through δ and 9½° on.

278 P. XIX. R. A., 19h. 41m. 44s.; Dec., + 34° 44.6'. A fine double. A 6, straw color; B 8, smalt blue; colors beautiful. D., 38.2". About 1° S. of last object.

2708 Σ. R. A., 20h. 34m. 30s.; Dec., + 38° 15.4'. A double star. A 4½, yellow; B 9½, blue. D., 24.6", and increasing. Line from α Cephei through α Cyg., and 7° on.

1470 H. R. A., 19h. 59m.; Dec., + 38° 0'. A beautiful double. A 8½, pale clear red; B 9½, intense blue. D., 23.8". A line from α to β passes about 1° due S. of it, 10½° from the former.

2048 h. (H. 4511.) R. A., 19h. 37m. 25s.; Dec., + 39° 56.1'. A rich cluster of very minute stars of mag. 11 to 15. 5° from δ on line to β.

20 ♅ VIII. (H. 4559.) R. A., 20h. 7m. 22s.; Dec., + 26° 9.6'. A large and rich but loose cluster of stars from mag. 6 to 11. Line from β Cassiopeæ through γ Cyg. and 18° on.

8 ♅ VII. (H. 4591.) R. A., 20h. 29m. 57s.; Dec., + 27° 56.2'. A large, bright and rich cluster. Line from ε Cassiopeæ, the northernmost star of the Chair, through ε Cyg. and 6½° on.

2107 h. (H. 4645.) R. A., 21h. 7m. 18s.; Dec., + 45° 13.8'. An extended and pretty rich cluster of principally 10th mag. stars. Between α and ρ, 6° from former, and due E.

39 M. (H. 4681.) R. A., 21h. 28m. 15s.; Dec., + 47° 56.9'. A brilliant cluster in a rich vicinity. Line from β through γ and 14° on.

56 ♅ VIII. (H. 4575.) R. A., 20h. 19m. 9s.; Dec., + 40° 25.6'. A beautiful group of stars, mag. 10 to 12. It is ½° from γ on line to α.

Delphinus (The Dolphin).

A little constellation which offers a very rich region for sweeping. Mean R. A., 20h. 20m.; Dec., + 12°; stars, 51.

γ. R. A., 20h. 41m. 33s.; Dec., + 15° 43.9′. A beautiful double. A 4, yellow; B 7, light emerald, but appears to vary in color, since it is described as yellow, green, and blue, by various observers. D., 11.3″. This constellation may be recognized by the little square of stars between Aquila and Pegasus; *γ* is the easternmost of these.

2703 Σ. R. A., 20h. 31m. 40s.; Dec., + 14° 21′. A pretty triple. A white, B yellowish, C white, all mag. 7½. D., AB 25.2″, AC 69.2″, BC 59.7″. This object is but 9′ N. and 43″ W. of *β*, the southernmost and largest star in the square.

Draco (The Dragon).

A winding and convoluted constellation, always above the horizon. Mean R. A., 15h. 55m.; Dec., + 70°; stars, 255.

α. (Thuban.) R. A., 14h. 1m. 24s.; Dec., + 64° 54.1′. A star with a distant companion. A 3½, pale yellow; B 8, dusky. Difference of R. A., 23.9s. This star is suspected of variability, having been rated as of magnitudes from 2 to 4.

δ. R. A., 19h. 12m. 31s.; Dec., + 67° 28′. A star with a distant companion. A 3, deep yellow; B 9½, pale red. D., 154.7″.

ι. R. A., 15h. 22m. 29s.; Dec., + 59° 21.1′. A bright star with distant companion. A 3, orange tint; B 9, pale yellow. D., 254.6″. Other stars in field. Line from Polaris through γ Urs. Min. and 12½° on.

o. R. A., 18h. 49m. 34s.; Dec., + 59° 15.3′. A neat double in a fine field. A 5, orange yellow; B lilac. D., 31.8″. A line from β Herculis through γ Drac. will pass within ½° of it, 10½° from the latter.

ψ^1. R. A., 17h. 43m. 54s.; Dec., + 72° 12.5′. A neat double. A 5½, B 6, both pearly white. D., 30.9″. 8° from δ on line to γ Urs. Min.

40. R. A., 18h. 8m. 16s.; Dec., + 79° 59′. A fine double. A 5½, B 6, both white. D., 20.1″. 10° from Polaris on line to γ.

2278 Σ. R. A., 18h. om. 58s.; Dec., + 56° 26′. A triple star. A 7½, B 8, both white; C 8½. D., AB 38.1″, AC 5.9″. 1¼° S. and a little E. from ξ, the 3d mag. star 6° N. of γ.

190 B. R. A., 18h. 31m. 26s.; Dec., + 52° 15.7′. A beautiful double. A 6, very yellow; B 8½, very blue. Colors very fine. D., 25.4″. 13° from Vega on line to the Pole.

2573 Σ. R. A., 19h. 38m. 30s.; Dec., + 60° 15.3′. A double star. A 6½, white; B 9, blue. D., 18.1″. Exactly on line from α Lyræ to Polaris, and 22° from the former.

256 H I. (H. 3671.) R. A., 13h. 45m. 33s.; Dec., + 60° 44.8′. An irregularly round nebula, brightening towards the centre. 11° from η Urs. Maj. on line towards Polaris.

102 M. (H. 4064.) R. A., 15h. 6m. 55s.; Dec., + 57° 25.6′. A small and rather faint nebula. 13° from η Urs. Maj. on line to ξ Drac.

37 ♅ IV. (H. 4373.) R. A., 17h. 58m. 35s.; Dec., + 66° 38′. A planetary nebula. It will prove difficult in a small telescope, but should be tried. Like other planetary nebulæ it somewhat resembles a star out of focus. A line from δ to η will pass within less than 1° S. of it, 7° from the former.

Equuleus (The Little Horse).

A diminutive asterism which offers, outside of its good low-power fields, but one object for our examination. Mean R. A., 21h. 10m.; Dec., + 5°; stars, 36.

355, 356 P. XX. R. A., 20h. 47m. 18s.; Dec., + 6° 55′. A pair of stars, both mag. 8½, both white. D., 40.3″. 15° from Altair on a line from θ Pegasi.

Eridanus (The River).

An extensive southern constellation, a large proportion of which is below the horizon in England and the United States. Mean R. A. of portion visible in latitude 40°, 3h. 40m.; Dec., − 25°; stars, 343.

32. R. A., 3h. 48m. 46s.; Dec., − 3° 16.8′. A splendid double. A 5, topaz yellow; B 7, sea-green or blue. D., 6.7″. Secchi calls the colors *magnifici, superbi.* Line from Sirius through Rigel, and 19° on.

39. R. A., 4h. 9m. 10s.; Dec., − 10° 31.6′. A delicate but not difficult double. A 5, yellow; B 11, deep blue. D., 6.3″. This star is known as A in some catalogues and maps. Line from ζ Orionis (lowest in belt), through β Erid. and 14½° on.

55. R. A., 4h. 38m. 18s.; Dec., − 8° 59.9′. A beautiful double. Both mag. 7½, both yellowish white. D., 9″. Line from ε Orionis through β Erid. and 7½° on.

62. R. A., 4h. 50m. 59s.; Dec., − 5° 20.8′. A wide double. A 6, white; B 8, lilac. D., 63.8″. Line from upper part of Orion's sword-cluster through β Erid. and 3° on.

f. R. A., 3h. 44m. 33s.; Dec., − 37° 57.8′. A superb double. A 5, B 5½. D., 8.5″. Line from upper part of Orion's sword-cluster through Rigel and 50° on.

2569 h. (H. 748.) R. A., 3h. 34m. 20s.; Dec., − 35° 48.9′. A globular cluster, nebulous in small telescope. A line from δ Orionis through β Erid. and 52° on will pass within 2° E. of this cluster.

26 Ħ IV. (H. 826.) R. A., 4h. 9m. 10s.; Dec., − 13° 1.3′. A planetary nebula, very faint in small telescope, and not bearing high powers. Lassell pronounces it the most interesting and extraordinary object of the kind which he had ever seen. Line from ε Orionis to β Erid. and 15° on. It is 4⅓° from γ, E. and a little N.

Gemini (The Twins).

A highly interesting and important constellation. Mean R. A., 7h.; Dec., + 22°; stars, 190.

α. (Castor.) R. A., 7h. 27m. 35s.; Dec., + 32° 7.8′. A splendid binary star, the largest and finest in the northern hemisphere. A 3, bright white; B 3½, pale white. D., 5.64″. The period of revolution of this magnificent system is, according to Thiele, 996 years.

β. (Pollux.) R. A., 7h. 38m. 35s.; Dec., + 28° 17.5′. A multiple star of 6 components. Our observer will see

it as a coarse triple. A 2, orange tinge ; D 9½ ; E 9. D., AD 206.3″, AE 229.2″.

γ. R. A., 6h. 31m. 21s.; Dec., + 16° 29.5′. A bright white star of mag. 3, in a beautiful field.

ε. R. A., 6h. 37m. 10s.; Dec., + 25° 14.3′. A star with distant companion. A 3, yellow ; B 9½, cerulean blue. D., 110.6″. Rather difficult.

κ. R. A., 7h. 37m. 48s.; Dec., + 24° 39.7′. A very delicate and beautiful but difficult double. A 4, orange ; B 10, pale blue. D., 6.39″. 4° due S. of Pollux.

R. R. A., 7h. 0m.; Dec., + 22° 53′. An extraordinary variable, from 6½ to 12½ mag. Period 371 days. According to Hind, this star is blue, red, and yellow, by turns. It yielded to Secchi a wonderful spectrum with bright lines. 10° from Pollux on line to γ.

15. R. A., 6h. 21m. 13s.; Dec., + 20° 51.5′. A fine double. A 6, flushed white ; B 8, bluish. D., 31″. 5° from γ on line to μ.

20. R. A., 6h. 25m. 52s.; Dec., + 17° 51.4′. A beautiful double in a fine field. A 8, topaz yellow ; B 8½, cerulean blue. D., 20″. 2° from γ on a line to η.

38. R. A., 6h. 48m. 26s.; Dec., + 13° 19.1′. A very fine double. A 5½, light yellow ; B 8, purple ; colors very marked. D., 6.3″. 5½° from γ on line to Procyon.

135 Birm. R. A., 6h. 4m. 3s.; Dec., + 26° 2.3′. A fine ruby star of mag. 7½ or 8. Line from γ 1° W. of μ, and 5° further.

540 South. R. A., 7h. 21m. 6s.; Dec., + 22° 22.2′. A beautiful pair. A 7½, red ; B 9, blue. D., 35.6″. 2° due E. of δ.

1108 Σ. R. A., 7h. 26m. 15s. ; Dec., + 23° 7.8″. A beautiful double. A 7, yellowish white ; B 9, bluish. D., 11.5″. Line from γ to δ and 3° on.

1035 Σ. R. A. (1880), 7h. 4m.; Dec., + 22° 29′. A beautiful double. Both mag. 7½, both yellowish. D., 8.5″. Line from γ to ζ and 2° on.

26 ℍ VIII. (H. 1325.) R. A., 5h. 54m. 24s.; Dec., + 23° 17.9′. A rather large cluster of 40 or 50 stars from mag. 8 to 15. 2½° W. and a little N. of η, is a 5th mag. star, ι. The cluster is 1¼° due W. of this star.

35 M. (H. 1360.) R. A., 6h. 2m. 4s.; Dec., + 24° 21.2′. A gorgeous cluster of stars from mag. 9 to 16. Smyth says: "From the small stars being inclined to form curves of three or four, and often with a large one at the root of the curve, it somewhat reminds one of the bursting of a sky-rocket." Lassell says: "A marvellously striking object. No one can see it for the first time without an exclamation. . . . Nothing but a sight of the object itself can convey an idea of its exquisite beauty." 3½° from μ on line to β Tauri.

40 ℍ VIII. (H. 1490.) R. A., 7h. 0m. 39s.; Dec., + 27° 21.7′. A large scattered cluster. 7° from Castor on line to Betelgeuse.

45 ℍ IV. (H. 1532.) R. A., 7h. 22m. 41s.; Dec., + 21° 8.1′. A star enveloped in a nebulous atmosphere about 25″ in diameter; a most remarkable object. The central star is of mag. 7½. Line from ϵ to δ and 2° on.

11 ℍ VIII. (H. 1534.) R. A., 7h. 22m. 53s.; Dec., + 13° 59.6′. A compressed cluster of very minute stars. 9° from Procyon on line to δ Gem.

HERCULES.

A large and very interesting constellation, although not conspicuous to the naked eye. Mean R. A., 16h. 50m.; Dec., + 32; stars, 451.

α. (Ras Algethi.) R. A., 17h. 9m. 38s.; Dec., + 14° 30.9′. A splendid double. A 3½, orange; B 5½, emerald or bluish green. D., 4.7″. Smyth calls this a lovely object, one of the finest in the heavens.

δ. R. A., 17h. 10m. 31s.; Dec., + 24° 58.3′. A beautiful double. A 4, greenish white; B 8½, grape red. D., 18.1″. Due N. of α 11°.

κ'. R. A., 16h. 3m. 6s.; Dec., + 17° 20.6′. A very pretty double. A 5½, light yellow; B 7, pale garnet. D., 29.8″. Line from β Lyræ to β Herc. and 7° on.

ρ. R. A., 17h. 19m. 53s.; Dec., + 37° 14.9′. A beautiful double. A 4, bluish white; B 5½, pale emerald. D., 3.89″. 2° from π on line to Wega.

36–37. R. A., 16h. 35m. 7s.; Dec., + 4° 26.1′. A pair of blue stars of mag. 6½ and 7½. D., 69.8″. It is 16° W. of β Ophiuci, just S. of a line from it to ϵ Serpentis.

95. R. A., 17h. 56m. 50s.; Dec., + 21° 35.8′. A lovely double. A 5½, light apple-green; B 6, cherry red. D., 6.1″. There is much difference of opinion as to the colors of these stars; Macdonnell pronounced both golden-yellow. About 12½° from α Ophiuci on line to β Lyræ.

100. R. A., 18h. 3m. 24s.; Dec., + 26° 4.8′. A neat double. Both mag. 7, both pale white. D., 14.1″. 12½° from β Lyræ on line to α Herculis.

2104 Σ. R. A., 16h. 44m. 45s.; Dec., + 36° 6.5′. A very pretty double. A 6½, white; B 8½, ash-colored. D., 5.9″. 4° from ζ on line to β Draconis.

2007 Σ. R. A. (1880), 16h. 1m.; Dec., + 13° 39′. A very fine pair. A 6½, yellowish-white; B 8, white. D., 32″. Line from β through γ and 7° on.

2087 Σ. R. A. (1880), 16h. 38m.; Dec., + 23° 51′. An exquisite little double. Both mag. 8, both white.

D., 5.7″. Line from *α* Serpentis through *β* Herc. and 4° on. Just S. and a little E. of this is

Σ 5 N. (H. 4234.) R. A., 16h. 39m. 51s.; Dec., + 24° 0′. A small pale-blue planetary nebula which bears magnifying well. Its disk is about 8″ in diameter, but ill-defined.

13 M. (H. 4230.) R. A., 16h. 37m. 45s.; Dec., + 36° 39.9′. A gorgeous cluster, one of the most magnificent objects in the heavens. It blazes toward the centre and has numerous outliers. It was discovered by Halley, and is sometimes called Halley's nebula. It is faintly visible to the naked eye; and "under telescopic aid," says Olmstead, "it reveals its glories in a form truly exciting to the beholder." Dr. Nichol, more enthusiastic, says: "Perhaps no one ever saw it for the first time through a telescope without uttering a shout of wonder." It is almost on a line (a little W.) between *η* and *ζ*, 3° from the former; and 7° from *α* on line to *ε* Boötis.

92 M. (H. 4294.) R. A., 17h. 13m. 46s.; Dec., + 43° 15.1′. A globular cluster, very luminous in centre; a splendid object. 16½° W. and a little S. from *α* Lyræ is a 3d mag., which is *π* Herculis. 92 M. is 7° from it on line to Polaris.

HYDRA (THE WATER-SNAKE).

A long winding constellation stretching through more than six hours of right ascension. Mean R. A., 11h. 26m.; Dec., − 17°; stars, 370.

α. (Al-fard, *the Solitary*, or Cor Hydræ.) R. A., 9 h. 22m. 11s.; Dec., − 8° 10.9′. A star with a difficult dis-

tant companion. A 2, but suspected of variability, orange tint; B 10, pale-green. D., 281.2″.

τ^1. R. A., 9h. 23m. 34s.; Dec., – 2° 17.2′. A wide double. A 5½, flushed white; B 8½, lilac.. (Colors according to Webb, pale-white, dusky.) D., 66.2″. 6° due N. of α.

R. R. A., 13h. 23m. 42s.; Dec., – 22° 42.7′. A remarkable variable. Its period is 436 days, and appears to be diminishing. Its extreme magnitudes during visibility are 4 and 10. It is of a pale orange-yellow tint, and has a distant greenish 8th mag. companion. D., 138.7″. 13½° from β Corvi on line to δ Scorpionis, and 12° S. and 1° E. of Spica.

10. R. A., 14h. 39m. 39s.; Dec., – 24° 58.4′. A very beautiful double. A 5½, pale orange; B 7½, violet tint. D., 9″. Line from σ Scorpii (the 3d mag. star 2° W. and N. of Antares) through γ Scorpii and 4½° on.

313 Birm. R. A. (1880), 13h. 42m.; Dec., – 27° 46′. A very fine ruby star; mag. 6½. Line from δ Scorp. to γ Scorp. and 18½° on.

108 P. VIII. R. A., 8h. 30m. 1s.; Dec., + 7° 0.5′. A fine double. A 6, pale yellow; B 7, rose-tint. D., 10.6″. A line from Procyon to Regulus passes 1° N. of this object at a distance of 13½° from the former.

27 H IV. (H. 2102.) R. A., 10h. 19m. 25s.; Dec., – 17° 35.6′. A fine planetary nebula, bearing magnifying well. Smyth compares it to Jupiter in size and equable light. Noble suggests that it resembles a ghost of Jupiter. It is of a pale bluish tint. Line from β Corvi to ϵ Corvi and 26° on. 2° S. and a little W. from μ.

68 M. (H. 3128.) R. A., 12h. 33m. 34s.; Dec., – 26° 7.6′. A pale nebula 3′ broad and 4′ long. 3½° S. and a little E. from β Corvi.

LACERTA (THE LIZARD).

A small constellation formed by Hevelius. Mean R. A., 22h. 19m.; Dec., + 52°; stars, 60.

α. R. A., 22h. 26m. 44s.; Dec., + 49° 43′. A star given here only for the noble field in which it is situated. Line from γ Cassiopeæ to β Cass. and 17° on.

8^2. R. A., 22h. 30m. 58s.; Dec., + 39° 3.9′. A quadruple star which will be double only in a small telescope. Both 6½, both white. The other components are of mag. 10 and 11. D., AB 22.3″. Line from γ Cygni to ν Cyg. and 19° on.

65 P. XXII. R. A., 22h. 14m. 6s.; Dec., + 37° 13′. A neat double. A 6½, pale white; B 9, livid. D., 15.4′. Line from β Lyræ to γ Cygni and 24° on. It closely follows 1 Lacertæ, a 5th mag. star.

75 H VIII. (H. 4773.) R. A., 22h. 11m. 57s.; Dec., + 49° 19.9′. A fine cluster, quickly followed by a beautiful field. The cluster is about 16′ long. Line from δ Cassiopeæ through β Cass. and 17° on.

LEO (THE LION).

A noble constellation, one of the most striking in the northern hemisphere. Mean R. A., 10h. 25m.; Dec., + 20°; stars, 337.

α. (Regulus.) R. A., 10h. 2m. 30s.; Dec., + 12° 30.3′. A fine star with a distant companion. A 1, flushed white; B 8½, pale purple. D., 177″. Decidedly difficult.

β. (Denebola.) R. A., 11h. 43m. 27s.; Dec., + 15°

11.2′. A bright star with a very distant companion. A 2½, bluish; B 8, dull red. D., 282″. Other stars in field.

γ. (Al Gieba.) R. A., 10h. 13m. 54s.; Dec., + 20° 23.8′. A splendid double; according to Struve, the finest in the northern sky. A 2, bright orange; B 4, greenish yellow. D., 3.61″, and increasing.

6. R. A., 9h. 26m. 4s.; Dec., + 10° 12.1′. A neat but difficult double. A 6, pale rose tint; B 9½, purple. D., 36.8″. Carry a line from β 1⅓° S. of α and 9° on.

83. R. A., 11h. 21m. 13s.; Dec., + 3° 36.7′. A pretty double. A 8, silvery white; B 9, pale rose tint. D., 29.5″. It closely precedes (a little N.) τ Leon., to find which draw a line from γ Virginis through β Virg. and 5⅜° further.

90. R. A., 11h. 28m. 59s.; Dec., + 17° 24.4′. A fine triple. A 6, silvery white; B 7½, purplish; C 9½, pale red. D., AB 3.5″, AC 63.3″. AB probably form a binary system. Line from δ Virginis through β Leon., and 4¼° on.

R. R. A., 9h. 41m. 39s.; Dec., + 11° 56.5′. A superb vivid red star, varying in 312 days from mag. 5 to 10. Hind says: "It is one of the most fiery-looking variables on our list—fiery in every stage from maximum to minimum, and is really a fine telescopic object in a dark sky, about the time of greatest brilliancy, when its color forms a striking contrast with the steady white light of the 6th magnitude, a little to the N." A line from α to Procyon will pass within ½° S. of this star, 5¼° from α.

1434 Σ. R. A. (1880), 10h. 21m.; Dec., + 18° 41′. A very pretty double. Both 8½ (Struve), both orange. D., 6.1″. 2⅜° from γ on line to δ Corvi.

95 M. (H. 2184.) R. A., 10h. 38m. 10s.; Dec., + 12° 16.3′. A lucid round white nebula. It is 8¾° due E. of α. About ¾° E. and somewhat N. of this, follows another round but paler nebula. (96 M., H. 2194.)

17 ♅ I. (H. 2203.) R. A., 10h. 42m. 1s.; Dec., +13° 9.4′. A round nebula brightening towards the centre. It is ⅔° N. a little E. from last object.

18 ♅ I. (H. 2207.) R. A., 10h. 42m. 28s.; Dec., +13° 12.3′. A faint round nebula, forming a pair with the last object.

13 ♅ I. (H. 2301.) R. A., 11h. 0m. 10s.; Dec., +0° 33.5. A pale white, well-defined elongated nebula. A line from γ Virginis carried ¾° under η Virg. and 18° on will reach this object.

66 M. (H. 2377.) R. A., 11h. 14m. 22s.; Dec., + 13° 34.9′. A large faint elongated nebula. 73s. from it towards the W. is another of similar shape, but smaller. This is 65 M., H. 2373. They are less than 1° S. of a line from β to α, 7½° from β.

Leo Minor (The Lesser Lion).

A small constellation of little importance, formed by Hevelius. Mean R. A., 10h. 20m.; Dec., + 38° ; stars, 96.

86 ♅ I. (H. 2104.) R. A., 10h. 21m. 6s.; Dec., +29° 4′. An oval nebula with central nucleus. Line from α 1½° W. of γ, and 8° on.

87 ♅ I. (H. 2274.) R. A., 10h. 54m. 12s. ; Dec., + 29° 34′. A large orbicular nebula. 6° from ν Urs. Maj. on line to Regulus.

LEPUS (THE HARE).

A small southern constellation, poor to the eye, but containing several very interesting objects. Mean R. A., 5h. 32m.; Dec., – 20°; stars, 66.

α. (Arneb.) R. A., 5h. 27m. 52s.; Dec., – 17° 54.2′. A not easy double. A 3½, pale yellow; B 9½, gray. D., 35.6″.

γ. R. A., 5h. 40m.; Dec., – 22° 20′. A beautiful pair, A 4, light yellow, B 6½, pale garnet. D., 92.9″.

R. R. A., 4h. 54m. 36s.; Dec., – 14° 58.2′. Hind's celebrated "Crimson Star." A superb object. Says Mr. Hind: "It is of the most intense crimson, resembling a blood-drop on the black ground of the sky; as regards depth of color, no other star visible in these latitudes could be compared to it." Line from *δ* Orionis to Rigel, and 7½° on.

875 Σ. R. A., 6h. 7m.; Dec., – 13° 7′. A pretty double. A 8.7, red; B 9.8, very green. D., 6″. 5⅜° from *β* Can. Maj. on line to *ζ* Orionis.

79 M. (H. 1112.) R. A., 5h. 19m. 53s.; Dec., – 24° 36.9′. A stellar nebula blazing towards the centre, and with a milky white tinge. A line from *α* to *β* and 4° on will pass within less than 1° E. of this object.

LIBRA (THE BALANCE).

A rather inconspicuous zodiacal constellation. Mean R. A., 15h. 8m.; Dec., – 13°; stars, 180.

α. (Kiffa Australis.) R. A., 14h. 44m. 47s; Dec., – 15° 35′. A wide but fine pair. A 3, pale yellow; B 6, light gray. D., 230.8.″

β. (Kiffa Borealis.) R. A., 15h. 11m. 5s.; Dec., – 8° 58.6'. A very beautiful pale green star, the color of which, as Webb remarks, is very unusual among conspicuous stars. And he adds: "Deep green, like deep blue, is unknown to the naked eye."

ι. R. A., 15h. 5m. 53s.; Dec., – 19° 22.4'. A wide but rather difficult pair. A 5½, pale yellow; B 9½, purple. D., 57.5". 13° due W. of β Scorpionis.

62 P. XIV. R. A., 14h. 16m. 49s.; Dec., – 17° 15.5'. A fine double. Both 8, both silvery white. D., 5.4". Line from β Virginis to Spica and 16° on.

1962 Σ. R. A., 15h. 32m. 43s.; Dec., – 8° 26'. A striking double. Both 6½, both white, or yellow according to Franks. D., 11.8". Line from σ Scorpionis to β Scorp. and 13° on. 6° from μ Serpentis on line to γ Scorp.

212 P. XIV. R. A., 14h. 50m. 55s.; Dec., – 20° 53.2'. A pretty double. A 6, straw color; B 8, orpiment yellow. D., 15.1". A line from γ Scorp. to α Lib. will pass within ½° E. of this star, 4½° from the former.

5 M. (H. 4083.) R. A., 15h. 12m. 57s.; Dec., + 2° 30.1'. A splendid cluster of minute stars, greatly compressed in the centre, and more than 7' or 8' in diameter. "A noble mass," says Smyth, "refreshing to the senses after searching for faint objects." 8½° from α Serpentis on line to β Corvi.

LYNX.

A large modern constellation formed by Hevelius. It contains little that is within the power of a small telescope. Mean R. A., 7h. 37m.; Dec., + 50°; stars, 149.

19. R. A., 7h. 13m. 53s.; Dec., + 55° 28.6'. A wide but pretty triple. A 7, white; B and C both 8, both plum-

colored. D., AB 14.3″, AC 215.2″. 27° from Polaris on line to Pollux.

40. R. A., 9h. 13m. 51s.; Dec., + 34° 49.5′. A fine deep orange-red star of mag. 4. This is sometimes known as α. Line from δ Urs. Maj. to γ Urs. Maj. and 33° on.

41. R. A., 9h. 21m. 27s.; Dec., + 46° 5.3′. A wide double. A 6½, B 8½, both bluish. D., 81.6″. 6½° from λ Urs. Maj. on line to κ Urs. Maj.

Lyra (The Lyre).

A small but splendid constellation, perhaps the finest, in proportion to its size, of them all. Mean R. A., 18h. 30m.; Dec., + 36°; stars, 166.

α. (Wega, Vega or Lyra.) R. A., 18h. 33m. 13s.; Dec., + 38° 40.9″. A grand pale-sapphire star of the first magnitude, one of the most splendid in the heavens. It has a minute blue companion of mag. 11, distant 48.1″, but although it has been seen by some observers with less than 2 inches, I doubt if the average eye can see it with anything under 3½ inches.

β. (Sheliak.) R. A., 18h. 46m. 1s.; Dec., + 33° 14.1′. A variable star ranging from mag. 3½ to 4½ in 12d. 21h. 53m. It has 4 companions of which our observer may see 3. B 8, pale gray; D 8½, faint yellow; E 9, lilac; D., AB 45.6″, AD 66.5″ AE 85.6″. A is called white by Smyth, yellow by Webb.

δ. R. A., 18h. 49m. 52s.; Dec., + 36° 50.3′. A star in a splendid low-power field, with a distant companion known as δ^2. A 4, orange; B 5, white.

ϵ. R. A., 18h. 40m. 41s.; Dec., + 39° 33.2′. A won-

derful multiple system. Under the slightest optical aid —an opera-glass is quite sufficient—this star is seen double; and with a high power each of the components is seen to be double. Between them are 3 minute stars, only one of which, of mag. $9\frac{1}{2}$, will be seen with a small telescope. Each of the minute pairs is a binary; the components of ϵ^1 having a period of about 2,000 years, those of ϵ^2 a period of about 1,000 years, and possibly both pairs revolve around their common centre of gravity in something less than 1,000,000 years. D., ϵ^1 ϵ^2, 207″; components of ϵ^1, 3.16″; of ϵ^2, 2.58″. Magnitudes, ϵ^1 5, ϵ^2 $6\frac{1}{2}$. Less than 2° E, and somewhat N. of α.

ζ. R. A., 18h. 40m. 59s.; Dec., + 37° 29.4′. A fine double. A 5, topaz; B $5\frac{1}{2}$, greenish. 2° from α, forming with it and ϵ a nearly equilateral triangle. D., 44.1″.

η. R. A., 19h. 10m. 1s.; Dec., + 38° 57.5′ A neat double. A 5, sky-blue; B 9, violet tint. A is yellow, according to Knott. D., 28.5″. $1\frac{1}{2}$° of a line from α to γ Cygni, and 6° from the former.

2372 Σ. R. A., 18h. 38m. 11s. Dec., + 34° 38.2′. A double star. A 7, white; B 9, clear blue. D., 24.9″. 3° from α on line to ζ Aquilæ.

56 B. R. A., 18h. 39m. 41s.; Dec., + 44° 49.4′. A double star. A 7, yellow; B 9, bluish white. D., 26.3″. 6° from ϵ on line to Polaris.

91 B. R. A., 18h. 50m. 51s.; Dec., + 33° 49.7′. A beautiful double (really triple). A 6, yellow; B 7, blue. D., 45.3″. Knott calls this "a charming miniature of β Cygni; the colors very fine." Less than 1° from β on line to θ, the star just S. of η.

2470 Σ. R. A., 19h. 4m. 44s.; Dec., + 34° 35.5′. A pretty double. A 7, B 9, both white. D., 13.3″. $2\frac{1}{2}$° from γ on line to θ.

57 M. (H. 4447.) R. A., 18h. 49m. 28s.; Dec., + 32° 53.6′. A wonderful annular nebula; the only one of the few in the heavens that is within the reach of a small telescope. It is a somewhat elliptical ring of light, about 80″ in diameter. According to Sir W. Herschel, it is distant from us 950 times as far as Sirius! It was considered that Secchi had resolved this nebula into stars, but Huggins finds only a gaseous spectrum. About ⅓ the distance between β and γ.

56 M. (H. 4485.) R. A., 19h. 12m. 16s.; Dec., + 29° 59.3′. A globular cluster of very minute stars, nebulous in a small telescope. It is in a splendid field. 5½° from β on line to β Cygni.

MONOCEROS (THE UNICORN).

A large modern constellation devised by Bartschius, Kepler's son-in-law. Mean R. A., 7h. 28m.; Dec., − 10°; stars, 220.

5. R. A., 6h. 9m. 30s.; Dec., 6° 14.4′. A fine orange star of mag. 4½. 7½° from κ Orionis on line to Procyon.

8. R. A., 6h. 17m. 56s.; Dec., + 4° 38.8′. A fine double in a glorious low-power field. A 4½, golden yellow; B 7, lilac. D., 13.9″. Line from Aldebaran through λ Orionis (the north star of the 3 in the head), and 13° on. Nearly 8° from α Orionis.

10. R. A., 6h. 22m. 31s.; Dec., − 4° 41.9′. A wide double in an elegant group. A 6, pale yellow; B 9, orange. D., 76.9″. It is nearly (a trifle S.) on a line from κ Orionis to Procyon, 11½° from the former.

11. R. A., 6h. 23m. 29s.; Dec., − 6° 57.7′. An ele-

gant triple, requiring high powers. Sir W. Herschel called it one of the most beautiful sights in the heavens. A 6½, B 7, C 8, all white. D., AB 7.2″, AC 9.6″, BC 2.7″. Line from Aldebaran to Bellatrix and 20¼° on.

104 P. VI. R. A., 6h. 22m. 4s.; Dec., + 0° 31′. A wide double. A 7½, topaz yellow; B 8½, plum tinge. D., 66.1″. B is itself double in powerful telescopes. "A low-power field includes 77, a fine 6th mag. yellow star, with this pair *n p* and another *s p*; a noble spectacle." (Webb.) 20° from Procyon on line to β Eridani.

116 P. VII. R. A., 7h. 22m. 42s.; Dec., – 11° 20′. A double star; in reality a delicate quintuple. A 7, yellow; B 9, violet. D., 23.4″. Line from λ Eridani (the 4th mag. star to the right of Rigel) to κ Orionis, and 24½° on.

2 ♅ VII. (H. 1424.) R. A., 6h. 25m. 4s.; Dec., + 5° 1.3′. A beautiful, brilliant cluster of stars from mag. 7 to 14, the latter running in rays. Line from β Eridani, midway between lowest and middle stars of Orion's belt, and 14½° on.

3 ♅ VIII. (H. 1429.) R. A., 6h. 28m. 46s.; Dec., + 8° 26.5.′ A large and rich cluster, but little condensed. Line from Bellatrix to Betelgeuse and 10° on.

27 ♅ V. (H. 1440.) R. A., 6h. 34m. 55s.; Dec., + 9° 59.8′. A magnificent stellar field, containing 15, a greenish 6th mag. star. Line from γ Orionis through α Or. and 11¾° on; the object will be found 1° due N. of the point so reached.

27 ♅ VI. (H. 1465.) R. A., 6h. 46m. 7s.; Dec., 0° 35.3′. A bright cluster, divided into 3 rich groups resembling 3 arms of a cross. Line from Aldebaran through Betelgeuse and 15¾° on.

50 M. (H. 1483.) R. A., 6h. 57m. 41s. Dec., – 8°

10.7'. A superb cluster, irregularly round and very rich. A line from Sirius to Procyon will pass 1° S. E. of this cluster, 9½° from Sirius.

34 ♅ VIII. (H. 1506.) R. A., 7h. 9m. 20s.; Dec., – 10° 5.7'. A rich field, containing an oval mass of stars and a fine double star. (1052 Σ.) Mags. 8 and 8½, both white. Line from α Leporis to θ Can. Maj. and 5½° on.

22 ♅ VI. (H. 1637.) R. A., 8h. 8m. 8s.; Dec., – 5° 28'. A rich splashy cluster containing a splendid group. Its alignment is very difficult, but it may be picked up thus: Carry a line from β Can. Min. to Procyon and 11½° on; from the point thus reached, line due S. 2½°.

Ophiucus (The Serpent-Bearer).

A large and, to the naked eye, rather dull constellation. Mean R. A., 16h. 50m.; Dec., – 3°; stars, 289.

36. R. A., 17h. 8m. 34s.; Dec., – 26° 25.3'. A fine double. A 4½, ruddy; B 6½, pale yellow. D., 5". 11½° from Antares on line to σ Sagit.

39. R. A., 17h. 11m. 18s.; Dec., – 24° 9.9'. A very beautiful double. A 5½, pale orange; B 7½, blue. D., 10.7". 17° from λ Sagit. on line to δ Scorp.

53. R. A., 17h. 29m. 23s.; Dec., + 9° 39.8'. A wide double. A 6, B 8, both bluish. D., 41.2". 3° due S. of α.

61. R. A., 17h. 39m. 3s.; Dec., + 2° 37.6'. A pretty double. A 6½, B 7, both white. D., 20.2." 1° W. of γ, and 2° S. of β.

67. R. A., 17h. 55m. 8s.; Dec., + 2° 56.2'. A wide double. A 4, straw-color; B 8, purple. D., 54.7". A

little W. and S. of this is a fine orange star which is 422 Birm. Line from 61 through γ' and 3° on.

124 B. R. A., 17h. 1m. 10s.; Dec., – 1° 30.2'. A double star. A 7, B 9, both white. D., 20.3". 16° from α on line to σ Scorp.

12 M. (H. 4238.) R. A., 16h. 41m. 31s.; Dec., – 1° 45.9'. A fine rich globular cluster, condensed towards centre. Nebulous in small telescope. 9° from ζ on line to κ.

10 M. (H. 4256.) R. A., 16h. 51m. 22s.; Dec., – 3° 56.8'. A rich globular cluster, blazing towards centre. About 8' in diameter. It is more easily resolved than 12 M. Of a lucid white tint. Line from σ Scorp. to ζ Oph. and 9° on.

19 M. (H. 4264.) R. A., 16h. 55m. 48s.; Dec., – 26° 6.9'. A fine globular cluster, nebulous in small telescope, of a creamy white tint. 8° from Antares on line to σ Sagit.

9 M. (H. 4287.) R. A., 17h. 12m. 37s.; Dec., – 18° 24.2'. A globular cluster of excessively minute stars, brightening towards centre. Nebulous in small telescope. 14½° from Antares on line to δ Aquilæ.

14 M. (H. 4315.) R. A., 17h. 31m. 50s.; Dec., – 3° 11.2'. A nebulous-looking cluster, rather faint in small telescope, but very interesting. 8° from β on line to θ.

23 M. (H. 4346.) R. A., 17h. 50m. 28s.; Dec., – 18° 58.9'. An "elegant sprinkling" of telescopic stars; a grand low-power field. Line from σ Sagit. to μ Sagit. and 4½° on.

11 H VI. (H. 4268.) R. A., 16h. 57m. 44s.; Dec., – 24° 36.3'. A globular cluster of small stars, condensed towards centre. 8° from Antares on line to σ Sagit.

Orion.

The most gloriously beautiful of all the constellations; splendid alike to the eye and to the telescope. Mean R. A., 5h. 26m.; Dec., 0°; stars, 304.

α. (Betelgeuse.) R. A., 5h. 39m. 14s.; Dec., + 7° 23′. A brilliant star which is probably variable to a slight degree, but never falls below the 1st magnitude. Its color is extremely striking. "A most beautiful and brilliant gem! singularly beautiful in color, a rich topaz; in hue and brilliancy different from any other star I have seen." (Lassell.) "Look at *α* and *β* alternately; even a small telescope will show the beauty of the contrast." (Webb.)

β. (Rigel.) R. A., 5h. 9m. 15s.; Dec., – 8° 19.9′. A splendid star with a small blue companion of mag. 9. D., 9.5″. Rigel itself has a blue tint which Knott pronounces one of the finest shades among the stars. The *comes* is a celebrated test-object; some abnormally keen-eyed observers, like Dawes and Burnham, have seen it with less than 2 inches, but 2½ inches, in most favorable weather, is the very lowest aperture, I think, that may ever be expected to show this little star to the average eye.

δ. R. A., 5h. 26m. 23s.; Dec., – 0° 22.9′. A very beautiful double, though wide. A 2, brilliant white; B 7, violet. D., 52.8″.

ε. R. A., 5h. 30m. 38s.; Dec., – 1° 16.4′. A star with a difficult distant companion. A 2½, bright white; B 10, pale blue. D., 179.9″.

ζ. R. A., 5h. 35m. 12s.; Dec., – 2° ·0.2′. A fine but difficult triple. A 3, topaz yellow, and very bright for its

magnitude; B 6½, light purple; C 10, gray. D., AB 2.61″, AC 57.1″. B is the star to which Struve applied what Chambers calls his "terrible adjective," *olivaceasubrubicunda.*

λ. R. A., 5h. 29m. 5s.; Dec., + 9° 51.5′. An elegant double. A 4, pale white; B 6, violet (yellow and blue, *Dembowski*). D., 4.3″. This is the northernmost of the 3 little stars in the head.

ρ. R. A., 5h. 7m. 32s.; Dec., + 2° 43.7′. A beautiful double. A 5, orange; B 9, smalt blue; colors very decided. D., 7.1.″ This is 5½° N. W. of δ, and the stars of the belt point almost upon it—a little above.

σ. R. A., 5h. 33m. 3s.; Dec., – 2° 38′. An extraordinary multiple system; a double-quadruple star with 2 stars between the systems. A small telescope will show it as a triple. A 4, bright white; B 8, bluish; C 7, grape red. D., AB 12.7″, AC 41.6″. Less than 1° S.W. of ζ.

23. R. A., 5h. 17m. 3s.; Dec., + 3° 26.3′. A neat double. A 5, white; B 7, pale gray. D., 31.1″. 3° from γ on line to β.

31. R. A., 5h. 23m. 59s.; Dec., – 1° 10.8′. A lovely golden star of mag. 5½. It has a very difficult blue *comes* of mag. 11. D., 12.7″. 1½° from δ on line to β.

96 Birm. R. A., 4h. 59m. 43s.; Dec., + 1° 1.6′. A splendid fiery red star, mag. 7. Line from Sirius through η and 6° on.

589 Σ. R. A. (1880), 4h. 38m.; Dec., + 5° 5′. A beautiful double, possibly binary. Both 8, both yellowish white. D., 4.5″. Line from β to β Erid. and 12° on.

278 P. IV. R. A., 4h. 56m. 18s.; Dec., + 1° 26.8′. A neat double. A 8½, silvery white; B 9, pale blue. D., 13.8″. Line from β Can. Maj. to κ Or. and 16° on. About 1° W. and somewhat N. of 96 Birm.

42 M. (H. 1179.) R. A. (of θ), 5h. 29m. 52s.; Dec., -5° 27.7. The Great Nebula in Orion. An overwhelming object: a vast tract of nebulous light, faintly visible to the naked eye, and growing in awful impressiveness with every increase of optical aid. In the angle of the strange gap in the nebula which is sometimes called the Fish's Mouth, lies θ, a multiple star, usually called the Trapezium, from the figure formed by its principal stars. It is readily seen with powers of from 50 upwards. The components of the Trapezium are of mags. 6, 7, 7½, and 8 In addition to these, θ contains two most minute stars of mag. 10½ and 12, which cannot be seen except with higher powers and larger apertures than the amateur can generally command. There are even other stars in or near the Trapezium, but they seem not to belong to the system.

78 M. (H. 1267.) R. A., 5h. 41m. 6s.; Dec. $+0^\circ$ 2.1′. Two stars in a "wispy" nebula. Mags. 8½ and 9. The object resembles a binuclear nebula. Faint, but most interesting. 7½° from α on line to β Leporis.

PEGASUS.

An extensive constellation, the interest of which, however, can hardly be considered proportional to its size. Mean R. A., 22h. 50m.; Dec., $+20^\circ$; stars, 393.

ϵ. (Enif.) R. A., 21h. 38m. 47s.; Dec., $+9^\circ$ 22.2′. A star with a distant companion. A 2½, yellow; B 9, violet. D., 140.2″.

1. R. A., 21h. 17m. 0s.; Dec., $+19^\circ$ 20′. A pretty but not easy double. A 4, pale orange; B 9, purplish.

D., 37.1″. Line from Altair to β Delphini (the brightest in that asterism), and $12\frac{1}{3}°$ on.

3. R. A., 21h. 32m. 14s.; Dec., + 6° 7.5′. A neat double. A 6, white; B 8, pale blue. D., 39.3″. A pretty little double in field, 8″ apart. Line from ϵ Peg. to β Aquarii; at a point $3\frac{1}{2}°$ from ϵ, draw a line about $\frac{3}{4}°$ W., and it will reach this star.

33. R. A., 22h. 18m. 21s.; Dec., + 20° 17.5′. A double star. A $6\frac{1}{2}$, yellowish; B 8, pale gray. D., 63.3″. Line from β Capric. to ϵ and $14\frac{1}{2}°$ on.

2848 Σ. R. A., 21h. 52m. 30s; Dec., + 5° 25′. A pretty double. A 8, white; B $8\frac{1}{2}$, yellowish or red. D., 10.6″. $5\frac{1}{4}°$ from ϵ on line to γ Aquar.

306 P. XXII. R. A., 23h. 2m. 12s.; Dec., + 32° 13.8′. A fine double. A 7, bright white; B $8\frac{1}{2}$, sapphire blue. D., 8.6″. 14° from α Androm. on line to ζ Cyg.

216 P. XXIII. R. A., 23h. 47m. 21s.; Dec., + 11° 18.8′. A neat double. Both $8\frac{1}{2}$, both silvery white. D., 18.7″. $5\frac{1}{2}°$ exactly S. W. of γ.

15 M. (H. 4670.) R. A., 21h. 24m. 34s.; Dec., + 11° 40.3′. A splendid globular cluster, nebulous in small telescope, but resolvable with a comparatively moderate aperture. There are some stars in the field, but Smyth remarks that the globular mass strikes the senses as being almost infinitely beyond these apparent *comites*. Line from θ to ϵ, and $4\frac{1}{2}°$ on.

PERSEUS.

A brilliant and beautiful constellation, situated in very fine portion of the Milky Way. Mean R. A., 3h 16m.; Dec., + 50°; stars, 196.

β. (Algol, *the Demon.*) R. A., 3h. 1m. 2s.; Dec., + 40° 31.9'. A wonderful variable, the most conspicuous of all the regularly variable stars. Its period is 2d. 20h. 49m., and its range from mag. 2 to 4. Its time of decrease and increase together occupy about 7 hours, and it remains at minimum but 18 minutes. Line from β Aurigæ through Capella and 24° on; or it may be recognized as the first conspicuous star 9½° S. a little W. from α.

η. R. A., 2h. 42m. 40s.; Dec., + 55° 26.3'. A beautiful double. A 5, orange; B 8½, smalt blue; colors clearly contrasted. D., 28.4". Line from α to γ and 3° on.

58. R. A., 4h. 29m. 2s.; Dec., + 41° 2.3'. A neat triple. A 5½, orange tint; B 7½, greenish; C 9, lilac. D., BC 11.8". 8½° from Capella on line to ζ.

220 P. II. R. A., 2h. 53m. 2s.; Dec., + 51° 54.9'. A neat double. A 6, silvery white; B 8, sapphire blue. D., 12.1". About 2° S. a little W. from γ.

104 B. R. A., 2h. 54m. 44s.; Dec., + 31° 58.6'. A pretty double. A 7, yellow; B 8½, blue. D., 8.8". 23° from β Androm. on line to Aldebaran.

76 M. (H. 385.) R. A., 1h. 35m. 2s.; Dec., + 51° 1.8'. An oval, pearly white nebula, binuclear, and pronounced by Webb a curious miniature of the Dumb-bell nebula. It is close to and N. of ϕ, the 4th mag. star 9° from γ Androm. on line to γ Cassiop.

33 H VI. (H. 512.) R. A., 2h. 11m. 20s.; Dec., + 56° 38.5'. A gorgeous cluster, followed closely by 34 H VI. (H. 521), another equally splendid mass, the two groups forming what is usually called the cluster in the sword-handle of Perseus. One of the central stars in the second group is of a fine ruby color. The two clusters are in the same field with a low power, and form one of

the most magnificent telescopic objects in the heavens. Just S. of a line from δ Cassiop. to γ Pers., and midway between them.

34 M. (H. 584.) R. A., 2h. 34m. 57s.; Dec., + 42° 15.7′. A beautiful scattered cluster. "A very grand low-power field, one of the finest objects of its class." (Webb.) Just N. of a line from γ Androm. to ι Pers., and $7\frac{1}{2}°$ from the former.

25 H VI. (H. 658.) R. A., 3h. 7m. 26s.; Dec., + 46° 49.4′. A beautiful compressed cluster, called by Smyth "an elegant sprinkle." "A low power shows a very faint large cloud of minute stars beautifully bordered by a foreshortened pentagon of larger ones." (Webb.) Midway between α and κ the 4th mag. star S. and W. of α.

88 H VIII. (H. 717.) R. A., 3h. 24m. 36s.; Dec., + 36° 56.7′. A large cluster of minute stars; about 60 in the group. 6° from Algol on line to Aldebaran.

61 H VII. (H. 820.) R. A., 4h. 6m. 52s.; Dec., + 50° 57.5′. A rich cluster, the larger stars arranged in curves. 11° from γ on line to Capella.

Pisces (The Fishes).

A large but particularly dull-looking constellation. Mean R. A., 0h. 25m.; Dec., + 20°; stars, 257.

α. R. A., 1h. 56m. 21s.; Dec., + 2° 14′. A close double. A 5, B 6. The most extraordinary differences of opinion exist as to the colors of the components. Smyth calls them pale green and blue; Dawes, both white, etc. D., 3.08″ and decreasing.

ζ. R. A., 1h. 7m. 59s.; Dec., + 6° 43.7'. A fine double. A 6, silver white; B 8, pale gray. D., 24.7". Line from η Erid. through Mira and 19° on.

ψ^1. R. A., 0h. 59m. 47s.; Dec., + 20° 53'. A fine double. Both $5\frac{1}{2}$, both silvery white. D., 29.8". Line from δ Cassiop. to β Androm. and 14° on.

35. R. A., 0h. 9m. 18s.; Dec., + 8° 12.6'. A fine double. A 6, pale white; B 8, violet tint. D., 11.6". Line from α Androm. to γ Pegasi and $5\frac{3}{4}$° on.

38. R. A., 0h. 11m. 44s.; Dec., + 8° 15.8'. An elegant double. A $7\frac{1}{2}$, light yellow; B 8, flushed white. D., 4.5". "Those sage astrologers who dubbed Pisces a most malignant sign, ought to have contemplated this beautiful object; had this been done, every notion of stellar unpropitiousness and malevolence must have vanished." (Smyth.) $\frac{3}{4}$° nearly due E. of last object.

51. R. A., 0h. 26m. 43s.; Dec., + 6° 20'. A fine but difficult double. A $6\frac{1}{2}$, pearl white; B 9, lilac tint. D., 28.4": $9\frac{1}{4}$° from γ Peg. on line to η Ceti.

55. R. A., 0h. 34m. 8s.; Dec., + 20° 50.7'. A very beautiful double. A 6, orange; B 9, deep blue, but rather faint. A fine specimen of opposed colors. D., 6.34." Line from α Cassiop. to δ Androm. and 9° on.

65. R. A., 0h. 43m. 58s.; Dec., + 27° 6.7'. A fine, close double. A 6, B 7, both pale yellow. D., 4.3". Some observers call both mag. 6. About $8\frac{1}{2}$° from α Androm. on line to β Arietis.

77. R. A., 1h. 0m. 8s.; Dec., + 4° 19.3'. A fine double. A $7\frac{1}{2}$, pale white; B 8, pale lilac. D., 33.3". Line from ζ Androm. to ϵ Pisc. and 3° on.

100. R. A., 1h. 29m. 1s.; Dec., + 11° 59.8'. A pretty double. A 7, white; B 8, pale gray. D., 16.4". Line from Mira through α and 12° on.

251 P. O. R. A., 0h. 53m. 45s. ; Dec., – 0° 11.4′. A neat double. A 8, pale orange ; B 9, clear blue. D., 20″. 10½° from θ′ Ceti on line to γ Pegasi.

PISCIS AUSTRALIS (THE SOUTHERN FISH).

A small constellation, important only for its beautiful *lucida*. Mean R. A , 22h. 15m. ; Dec., — 29° ; stars, 77.

α. (Fomalhaut.) R. A., 22h. 51m. 34s. ; Dec., – 30° 12.3′. A fine reddish star with a very distant dusky blue companion of mag. 9½. Difference of R. A., 4.8s.

SAGITTA (THE ARROW).

A diminutive constellation in the Milky Way. Mean R. A., 19h. 33m. ; Dec., + 18° 30′ ; stars, 34.

ε. R. A., 19h. 32m. 18s. ; Dec., + 16° 12.9′. A star with distant companion. A 6, pale white ; B 8, light blue. D., 92.2″. 6½° from γ Aquilæ on line to Wega.

θ. R. A., 20h. 5m. 5s. ; Dec., + 20° 35.2′. A triple. A 7, pale topaz ; B 9, gray ; C 8, pearly yellow. B is very difficult. D., AB 11.5″, AC 76.4″. Line from β Ceph. to γ Cyg. and 19° on.

χ. R. A., 19h. 55m. 5s. ; Dec., + 17° 13′. A 6th mag. orange star, the *lucida* of a beautiful group containing a smaller very red star, and a pretty little 10th mag. pair. 7½° from γ Aquilæ on line to ε Cyg.

SAGITTARIUS (THE ARCHER).

A large and important zodiacal constellation. Mean R. A., 19h. 15m. ; Dec., – 44° ; stars, 339.

μ^1. R. A., 18h. 7m. 10s.; Dec., $-21°$ 5.2′. A triple star. A 3½, pale yellow; B 9½, blue; C 10, reddish. D., AB 48.3″, AC 50.1″. It is the 4th mag. star 6° N.W. of λ.

294 P. XVII. R. A., 17h. 52m. 0s.; Dec., $-30°$ 14.9′. A fine double. A 6, B 7½, both strong yellow. D., 5.6″. 1⅜° due W. of γ.

8028 Lacaille. R. A., 19h. 5m. 32s.; Dec., $-34°$ 0.5′. A pretty double. Both mag. 7. D., 15″. A line from σ to ζ, carried 4° on, reaches a point 1⅓° due W. of this star.

5112 h*. R. A., 19h. 17m. 4s.; Dec., $-18°$ 12′. A striking triple (really quintuple). All 3 of mag. 8. D., AB 23.5″, AC 20.″ E. of, and very close to, ρ and ρ^2, the close naked-eye pair 4½° N.E. from π.

505. Birm. R. A., 19h. 28m. 0s.; Dec., $-16°$ 36.8′. A fine ruby star of mag. 6½. A line from δ to π, and 7½° on, reaches a point less than 1° due S. of this star.

3702 a. h. (H. 4324.) R. A., 17h. 38m. 29s.; Dec., $-33°$ 38.5′. A cluster of tolerable richness, the components ranging from mag. 8 to 12. 7¾° S.W. of γ.

13 VIII VI. (H. 4335.) R. A., 17h. 43m. 35s.; Dec., $-30°$ 10.9′. A cluster composed principally of 12th mag. stars. A curious rift in the middle. 3½° nearly due W. (a trifle N.) from γ.

7 M. (H. 4340.) R. A., 17h. 46m. 40s.; Dec., $-34°$ 47.2′. A cluster of stars from mag. 7 to 12. Rich but rather straggling. A line from δ Scorp. to Antares, and 22½° on, will pass about 1° S. of the cluster.

8 M. (H. 4361.) R. A., 17h. 57m. 8s.; Dec., $-24°$ 22.6′. A singular and splendid nebula. "In a large field we find a bright coarse triple star, followed by a resolvable luminous mass, including two stars or starry

centres, and then by a loose bright cluster enclosed by several stars." (Webb.) Sir J. Herschel remarks that the cluster seems to be superposed upon the nebula. $5\frac{3}{8}°$ almost exactly N. of γ.

21 M. (H. 4367.) R. A., 17h. 58m. 2s.; Dec., $-22°$ 30.8′. A coarse cluster of telescopic stars in a rich galaxy region. $1\frac{3}{8}°$ due N. of last object.

3729 h. (H. 4376.) R. A., 18h. om. 36s.; Dec., $-23°$ 14′. A large rich cluster. $2\frac{1}{2}°$ S.W. of μ^1.

30 VIII VII. (H. 4388.) R. A., 18h. 6m. 8s.; Dec., $-21°$ 35.8′. "A curious large undefined cloud of 10th mag. stars, requiring low power and steady gazing." (Webb.) $\frac{3}{4}$ S.W. of μ^1.

Scorpio (The Scorpion).

A superb constellation, the most brilliant of the Southern asterisms that are visible in our latitudes. Mean R. A., 16h. 35s.; Dec., $-33°$; stars, 200.

α. (Antares.) R. A., 16h. 22m. 39s.; Dec., $-26°$ 11.2′. A splendid star of mag. 1, of a fiery red color. "It is a grand telescopic object. Its tint, however, is not uniform. To me the disc appears yellow, with flashes of deep crimson, alternating with a less proportion of fine green." (Webb.) It has a minute green companion of mag. 7, D., 3.02″, which is a noted and severe test. It has been seen by Warner with $2\frac{3}{4}$ inches, but Proctor doubts whether anything under four inches may be expected to show it. The possessor of a 3-inch may try it under favorable atmospheric conditions, especially if he happens to live S. of latitude 40°.

β. (Acrab.) R. A., 15h. 59m. 2s.; Dec., $-19°$ 30.2′. A fine double. A 2, pale white; B 5½, lilac tinge. D., 13.5″.

ν. R. A., 16h. 5m. 36s.; Dec., $-19°$ 10.3′. A multiple star; double in a small telescope. A 4, bright white; B 7, pale lilac. D., 40.8″. 1⅜° E. and a little N. from *β*.

80 M. (H. 4173.) R. A., 16h. 10m. 26s.; Dec., $-22°$ 43.2′. A compressed globular cluster of extremely minute stars. It has a nebulous or cometary aspect. Sir W. Herschel called it the richest and most condensed mass of stars which the firmament can offer to the contemplation of astronomers; a description which the worker with a small telescope will hardly appreciate. Near its centre, but probably between us and it, is the variable T, which in 1860 had risen to the 7th magnitude, entirely overpowering the cluster, but in less than a month faded out, and has not (1893) been seen distinctly since. Exactly midway between *α* and *β*.

4 M. (H. 4183.) R. A., 16h. 16m. 53s.; Dec., $-26°$ 14.8′. A pale, elongated cluster, nebulous in small telescopes, about 2.5′ long, and brightening towards the centre. 1⅜° W. of Antares; 1° S. a trifle E. from *σ*.

62 M. (H. 4261.) R. A., 16h. 54m. 14s.; Dec., $-29°$ 55.4′. A fine resolvable nebula, brightening towards the centre. Line from *σ* to *α* and 8⅜° on.

Scutum Sobieski. *See* Clypeus Sobieski.

Serpens (The Serpent).

A long winding constellation of little interest; really a part of Ophiucus. Mean R. A., 16h. 45m.; Dec., 0°; stars, 187.

θ. R. A., 18h. 50m. 45s.; Dec., + 4° 3.4′. A beautiful double. A 4½, pale yellow; B 5, golden yellow. D. 21.6″. A noble pair. It lies 1½° S. of a line from *δ* Aquilæ to *α* Ophiuci, and 7½° from *δ* Aq.

72 ℍ VIII. (H. 4410.) R. A. (1880), 18h. 22m.; Dec., + 6° 29′. A very fine cluster of small stars. "Between it and *θ*, nearer the former, is a beautiful large cloud of stars, chiefly 8 and 9 mag., a nearer part, apparently, of the Galaxy; visible to naked eye, and requiring a large field." (Webb.) 7° from *θ*, almost on a line (a trifle S.) from *θ* to *α* Oph. *α* Herc. and *α* Oph. point almost to it.

SEXTANS (THE SEXTANT).

A small and unimportant asterism formed by Hevelius. Mean R. A., 9h. 56m.; Dec. + 2°; stars, 112.

163 ℍ I. (H. 2008.) R. A., 9h. 59m. 45s.; Dec., – 7° 11.3′. An elongated bright nebula which is possibly variable, since Sir J. Herschel could scarcely see it with six inches of his 20-foot reflector, while it is now readily visible, and bears magnifying unusually well, in a 2½-inch refractor. Extend a line 9½° due E. from *α* Hydræ; and from this point, a line 1⅓° due N.

TAURUS (THE BULL).

A brilliant and beautiful constellation, of the highest interest both to the naked eye and the telescope. Mean R. A., 4h. 3m.; Dec., + 16°; stars, 394.

α. (Aldebaran.) R. A., 4h. 29m. 36s.; Dec, + 16° 17.5′. A noble red star, pale rose tint, with a blue tele-

scopic companion. D., 113.9″. The companion is a difficult object, but a $3\frac{1}{2}$-inch will show it.

θ^1 θ^2. R. A., 4h. 22m. 16s.; Dec., + 15° 43.1′. A beautiful wide pair. A 5, pearly white; B $5\frac{1}{2}$, yellowish. D., 337.3″. These stars are next to α in the V that marks the Hyades.

κ^1 κ^2. R. A., 4h. 18m. 38s.; Dec., + 22° 2.5′. A fine wide pair. A $5\frac{1}{2}$, yellowish white; B $6\frac{1}{2}$, white. D., 339″. 7° from α just E. of a line from α to ζ Pers.

τ. R. A., 4h. 35m. 38s.; Dec., + 22° 44.8′. A star with rather distant companion. A 5, bluish white; B 8, lilac. D., 63.3″. 7° from α on line to Capella.

φ. R. A., 4h. 13m. 34s.; Dec., + 27° 5.4′. A beautiful wide double. A 6, light red; B $8\frac{1}{2}$, cerulean blue. D., 53.7″. A red 7th mag. star follows it by 15′. 12° from α on line to α Pers.

χ. R. A., 4h. 15m. 53s.; Dec., + 25° 22.2′. A pretty double. A 6, white; B 8, pale blue. D., 19.2″. 2° S. a trifle E. from ϕ.

62. R. A., 4h. 17m. 22s.; Dec., + 24° 2.8′. A pretty double. A 7, silver white; B $8\frac{1}{2}$, purple. D., 28.9″. In a fine field. The last two objects point directly to it, χ lying almost midway between φ and 62.

118. R. A., 5h. 22m. 30s.; Dec., + 25° 3.6′. An elegant double. A 7, white; B $7\frac{1}{2}$, pale blue. D., 5.1″. 3° from β, a trifle W. of a line from β to ζ.

257 P. IV. R. A., 4h. 52m. 44s.; Dec., + 14° 22.5′. A beautiful wide triple. A 7, white; B 8, cerulean blue; C 10, purple. D., AB 39″, AC 54.2″. Line from Betelgeuse through the triangle of Orion's head and $10\frac{1}{2}$° on.

548 Σ. R. A. (1880), 4h. 21m.; Dec., + 30° 6′. A pretty double. A 6, yellowish; B 8, bluish. D., 14.2″. 8° from τ, on line to α Pers.

785 Σ. R. A. (1880), 5h. 39m.; Dec., + 25° 53′. A pretty double. A 6½, white; B 7½, bluish white. D., 13.8″. 5° from β, a trifle E. from a line from β to η Gemin.

4 ♅ VII. (H. 1030.) R. A., 5h. 5m. 42s.; Dec., + 16° 34.1′. A very rich cluster of small stars, more than filling the field. 8½° from α on line to γ Gemin.

1 M. (H. 1157.) R. A., 5h. 27m. 51s.; Dec., + 21° 56.6′. A pearly white nebula, the famous "Crab Nebula" of Lord Rosse, and notable as the object the accidental discovery of which by M. Messier in 1758 led to the formation by him of the first catalogue of nebulæ. It is of an oval form, and bears some resemblance to a telescopic comet, for which it has more than once been mistaken. 1⅓° from ζ on line to ζ Pers.

THE PLEIADES. Mean R. A., 3h. 38m.; Dec., + 23° 30′. This famous and most beautiful group of stars forms a glorious low-power field. Tempel's Nebula, a faint triangular haze involving Merope, the star *s p* Alcyone the brightest of the group, should be looked for, as it has been seen with less than 2 inches. It is suspected, with good reason, of variability.

THE HYADES. Mean R. A., 4h. 20m.; Dec., + 15°. This group gives several fine low-power fields. It is about 2° W. and a little S. of α.

TRIANGULUM (THE TRIANGLE.)

A small but ancient asterism. Mean R. A., 2h. 5m.; Dec., + 32°; stars, 33.

ι. R. A., 2h. 5m. 59s.; Dec., + 29° 47.2′. A most beautiful double. A 5½, topaz yellow; B 7, green. D.,

3.86″. Colors very fine. Line from γ Androm. to β Triang. and 4½° on.

28 B. R. A., 2h. 8m. 17s.; Dec., + 29° 53.1′. A pretty double. Both 8, both very white. D., 6.41″. 2m. 18s. E. of ι, and 6′ towards the N.

33 M. (H. 352.) R. A., 1h. 27m. 38s.; Dec., + 30° 6.8′. A large faint nebula, only visible with low powers. It is about 30′ in diameter. One of the Rosse "spirals." Line from ϵ Pers. to β Triang. and 8½° on.

URSA MAJOR (THE GREATER BEAR).

A grand constellation, one of the noblest of them all. Mean R. A., 10h. 38m.; Dec., + 56°; stars, 338.

α. (Dubhe.) R. A., 10h. 56m. 56s.; Dec., + 62° 20.7′. A bright star with a very distant companion. A 1½, yellow; B 8, yellow (violet, *Webb*). D., 380.6″.

β. (Merak.) R. A., 10h. 55m. 12s.; Dec., + 56° 58.3′. A star with a very distant and difficult companion. A 2, greenish white; B 11, pale gray. D., 245.″ Others in field.

δ. (Megrez.) R. A., 12h. 9m. 58s.; Dec., + 57° 38.6′. A fine star with a distant companion. A 3, pale yellow; B 9, ash-colored. A is suspected of being variable between mag. 2 and 4 at a very long period. D., 188.6″.

ζ. (Mizar.) R. A., 13h. 19m. 29s.; Dec., + 55° 30.1′. A splendid double. A 3, brilliant white; B 5, pale emerald. D., 14.57.″ Alcor, a 5th mag. star 11½′ from Mizar, forms with it a naked-eye double.

57. R. A., 11h. 23m. 9s.; Dec., + 39° 56.5′. A beau-

tiful double. A 6, lucid white; B 9, violet. D., 5.43″. $7\frac{1}{2}°$ from ν, a trifle E. of line from ν to δ.

1402 Σ. R. A., 9h. 57m. 31s.; Dec., + 56° 0.8′. A pretty double. A $7\frac{1}{2}$, yellow; B $8\frac{1}{2}$, bluish. D., 23.5″. 6° from θ on line to β.

1603 Σ. R. A., 12h. 2m. 38s.; Dec., + 56° 5′. A neat double. A $7\frac{1}{2}$, B 8, both white. D., 22.4″. About midway between γ and δ.

205 H I. (H. 1823.) R. A., 9h. 14m. 24s.; Dec., + 51° 28.1′. An elliptical nebula about 4′ long, a miniature of the great Andromeda nebula. It is pale white, and nucleated. 2° from θ on line to ι.

78 H I. (H. 1909.) R. A., 9h. 40m. 32s.; Dec., + 72° 47.7′. A round nebula. Line from ζ to λ and 9° on.

81 and 82 M. (H. 1949, 1950.) Mean R. A., 9h. 46m. 23s.; Dec., + 69° 38.8′. The first of these is oval. The other is $\frac{1}{2}°$ S. of 81, and is long and narrow. η and ζ point to them. 27° from ζ.

286 H I. (H. 1982.) R. A., 9h. 53m. 36s.; Dec., + 69° 16.3′. A round lucid white nebula, brightening towards centre. "There are two lines of three stars each across the field, of which the one preceding the nebula is of the 7th mag. and that following of the 10th; between these the sky is intensely black, and shows the nebula as if floating in awful and illimitable space, at an inconceivable distance." $1\frac{3}{4}°$ E. and $\frac{1}{8}°$ N. of last object.

46 H V. (H. 2318.) R. A., 11h. 4m. 59s.; Dec., + 56° 15.6′. A faint but large and well-defined elongated curved nebula. About $1\frac{1}{2}°$ from β nearly on line to γ.

97 M. (H. 2343.) R. A., 11h. 8m. 19s.; Dec., + 55° 36.7′. A wonderful planetary nebula, large and pale,

about 2′ 40″ in diameter. If this nebula were only as distant from us as 61 Cygni, its real diameter would be seven times that of the orbit of Neptune; but as its distance was actually beyond the gauging powers of Herschel's 20-foot reflector, it must be, according to Sir William's estimate, at least of the 980th order; in other words, 980 times the distance of Sirius! Its actual dimensions must be, then, of a character that, in Admiral Smyth's phrase, makes the imagination quail. Less than 1° S.E. of last object.

173 ♅ I. (H. 2600.) R. A., 11h. 47m. 12s.; Dec., + 37° 36.2′. A pale white nebula, brightening towards the middle, of considerable size. Line from Polaris to γ and 17° on; then a trifle E.

43 ♅ V. (2841.) R. A., 12h. 13m. 33s.; Dec., + 47° 54.5′. A white oval nebula, better defined at edges than at ends. It has a nucleus in its southern portion. Line from α to γ, and 7½° on.

URSA MINOR (THE LESSER BEAR).

A small, but, from its position, highly important constellation. Mean R. A., 15h. 9m.; Dec., + 79°; stars, 75.

α. (Polaris.) R. A., 1h. 18m. 14s.; Dec., + 88° 43.3′. The Pole-Star, the most important of all the stars to the inhabitants of our planet. It is a noted double. A 2½, topaz yellow; B 9½, pale white. D., 18.5″. This is a well-known test. It has been seen by some observers with as low as one inch, but Dawes suggests, that, as a general rule, a good 2-inch and a good eye should detect the little star

with the power of 80. The smallest aid that shows it to me is $2\frac{1}{2}$ inches with a power of 64.

VIRGO (THE VIRGIN).

A noble constellation of great dimensions, and replete with astronomical interest. Mean R. A., 13h. 16m.; Dec., -2° 30′; stars, 411.

α. (Spica.) R. A., 13h. 19m. 24s.; Dec., -10° 35.2′. A beautiful bright star with a distant telescopic companion. A 1, brilliant flushed white; B 10, bluish tinge. D., 359.8″.

γ. R. A, 12h. 36m. 5s.; Dec., -0° 50.8′. A splendid and famous binary with a period of about 180 years. Both 4. both yellowish. D. (1880), 5.24″. This noble pair appeared single to all but the most powerful telescopes in 1836, and has been widening ever since.

S. R. A. (1880), 13h. 27m.; Dec., -6° 35′. A vivid red variable, ranging in 374 days from mag. $7\frac{1}{2}$ to $12\frac{1}{2}$. It is said to show especially a feature of several variables, a striking twinkling at times, particularly on the point of diminution. (Webb.) $4\frac{3}{4}^\circ$ from Spica on line to Arcturus.

32 P. XII. R. A., 12h. 12m. 30s.; Dec.,—3° 20.5′. A fine double. Both $7\frac{1}{2}$ (though some observers rate them as differing by half a magnitude), and both white. D., 20.1″. $3\frac{1}{2}^\circ$ from η on line to ϵ Corvi.

196 P. XII. R. A., 12h. 45m. 39s.; Dec., -9° 44.4′. A very pretty double. A $6\frac{1}{2}$, topaz yellow; B $9\frac{1}{2}$, lucid purple. D. 32.3″. $6\frac{3}{4}^\circ$ from θ on line to δ Corvi.

221 P. XII. R. A., 12h. 49m. 59s.; Dec., + 12° 5.7′.

A neat double. A $7\frac{1}{2}$, pale white ; B 9, sky blue (reddish, *Sadler*). D., 29.1″. 2° W. a trifle N. from ε.

25 P. XIII. R. A, 13h. 9m. 11s.; Dec., – 10° 45.4′. A pretty though wide double. A $7\frac{1}{2}$, B $8\frac{1}{2}$, both bluish. D., 42.4″. $2\frac{1}{2}$° W. of α.

88 M. (H. 3049.) R. A., 12h. 26m. 26s.; Dec., + 15° 1.9′. A long elliptical nebula, 7′ x $1\frac{1}{2}$′ in size. Line from α to δ and $12\frac{1}{2}$° on. "This is a wonderfully nebulous region, and the diffused matter occupies an extensive space, in which several of the finest objects of Messier and the Herschels will readily be picked up by the keen observer in extraordinary proximity. It will be convenient to keep in mind that the situation of the extraordinary conglomerate of nebulæ and compressed spherical clusters which crowd the Virgin's left wing and shoulder is pretty well pointed out to the practised naked eye by ε, δ, γ, η and β Virg. forming a semicircle to the E., whilst due N. of the last-mentioned star, β Leonis marks the N.W. boundary. Reasoning upon the Herschelian principle, this may reverently be assumed as the thinnest or shallowest part of our firmament, and the vast laboratory of the segregating mechanism by which compression and insulation are ripened in the course of unfathomable ages. The theme, however imaginative, is solemn and sublime." (Smyth.)

98 M. (H. 2786.) R. A., 12h. 8m. 34s.; Dec., + 15° 30.5′ A faint and pale elongated nebula. $6\frac{1}{4}$° nearly due E. (a trifle N.) from β Leonis.

87 M. (H. 3035.) R. A., 12h. 25m. 15s.; Dec., + 12° 59.4′. A large, round nebula, brighter at centre $8\frac{1}{4}$° from ε on line to β Leonis.

31 Ꮚ I. (H. 3075.) R. A., 12h. 28m. 28s.; Dec., + 8° 18.1′. An extended nebula much brighter in centre.

Line from α to θ and $15\frac{1}{2}°$ on. There is splendid sweeping with a low power all through this nebulous region; but identification is very difficult, and only a few typical nebulæ have been here described.

BENEDICITE OMNIA OPERA DOMINI DOMINO;
BENEDICITE SOL ET LUNA DOMINO;
BENEDICITE STELLÆ CŒLI DOMINO;
LAUDATE ET SUPEREXALTATE EUM IN SÆCULA